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HIGH-ALTITUDE ATMOSPHERIC MEASUREMENTS FOR THE REENTRIES OF GEMINI 6 AND GEMINI 7

By David E. Pitts and Patricia C. Carter
Manned Spacecraft Center
Houston, Texas

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ABSTRACT

The atmospheric wind, density, pressure, temperature, and speed of sound are reported for the reentries of Gemini 6 on December 16, 1965, and for Gemini 7 on December 18, 1965. Sources of the data were: Arcasondes at Cape Kennedy and Grand Turk Island; a Nike-Cajun falling sphere at Eglin Air Force Base; and Rawinsondes at Cape Kennedy and at the three islands - Grand Turk, Eleuthera, and Grand Bahama. Vertical extrapolations were used to extend the Arcasonde data above 160 000 feet. Horizontal extrapolations were used to determine the atmospheric quantities along the reentry ground track. Comparisons of the atmospheric winds, as measured by the Arcasonde parachute and the falling sphere, showed remarkable agreement. Above 70 kilometers, the density structure, as recorded by means of the falling sphere, showed reasonable agreement with the extrapolation of the Arcasonde; below 70 kilometers, more disagreement was noted.

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SUMMARY

The atmospheric measurements presented herein for the reentries of Gemini 6 and Gemini 7 are based upon passive-falling-sphere and Arcasonde soundings made along the Gulf Coast and in the Caribbean Sea in December 1965. The Arcasonde data consist of temperatures and winds up to 200 000 feet, while the passive-falling-sphere data are comprised of density and winds up to 328 000 feet. Other atmospheric quantities were obtained by numerical integration of the hydrostatic equation. A horizontal extrapolation, using the thermal wind equations, the geostrophic wind equations, and the mass-wind equations, was used to provide Arcasonde data along the reentry ground track. Unsuccessful Arcasondes at Eglin Air Force Base (AFB) made necessary the use of this extrapolation technique on the Arcasonde data taken at Cape Kennedy in order that a comparison could be made with the Nike-Cajun falling-sphere experiment at Eglin AFB. Next, a vertical extension technique was applied to the Arcasonde data to raise the upper limit to 400 000 feet.

The winds measured by the falling sphere and the Arcasonde at Eglin AFB compare closely to winds measured by the Arcasondes at Cape Kennedy. The maximum west wind was 15 to 20 meters/second greater at Eglin AFB. The temperatures deduced from the falling sphere were 35° K greater than standard at 180 000 feet and 28° K less than standard near 215 000 feet. The density as measured by the falling sphere was 18 percent greater than the Arcasonde extrapolation at 215 000 feet and was 13 percent less than the Arcasonde at 180 000 feet. The temperatures and densities agree well with the extrapolation above the transonic region of the falling sphere which occurs at 230 000 feet (70 km).

Known features of the temperature, pressure, wind, and density structure (such as the 8-km isopycnic level, the 24-km level of reduced variability, and the proposed 90-km isopycnic level) are evident in the Arcasonde data and in the extrapolations for Eglin AFB, Cape Kennedy, and Grand Turk Island. These combined data are tabulated from 80 000 feet to 400 000 feet. Density is given along the ground tracks, from the surface up to 400 000 feet.

INTRODUCTION

The reentry of Gemini 6 occurred on December 16, 1965, at 1524 Greenwich mean time (G. m. t.), and the reentry of Gemini 7 occurred on December 18, 1965, at 1352 G. m. t., at which times each spacecraft was at an altitude of 300 000 feet. The reentry ground tracks of the two vehicles were very similar, with both passing over south Texas, the northern Gulf of Mexico, southern Florida, and the eastern Caribbean (see fig. 1). Atmospheric measurements were taken at every available station near the ground tracks. Successful Arcasondes were fired from Cape Kennedy, Florida, and from Grand Turk Island; and Rawinsondes were launched from Eglin Air Force Base (AFB), Cape Kennedy, Grand Bahama Island, Eleuthera Island, and Grand Turk Island. The failures of several Arcasondes and the primary Nike-Cajun falling-sphere experiment were apparently related to the inclement weather conditions at Eglin AFB. The backup falling-sphere experiment was successful.

The Arcasonde has been used in support of the Gemini reentry phase on each flight; however, its limited altitude (200 000 ft) necessitates extrapolating the data to higher altitudes (above 300 000 ft) so that these data can be used for computing reentry heating rates and reentry aerodynamics of the Gemini spacecraft. The purpose of this paper is to compare the vertical extrapolation of the Arcasonde to the passive-falling-sphere measurements, which give density data up to 328 000 feet.

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SYMBOLS

a some altitude less than b

b some altitude greater than a

C_p specific heat of the atmospheric gas at constant p

C_v specific heat of the atmospheric gas at constant volume

c_s speed of sound

f	coriolis parameter = $2\omega \sin \Phi$
G	mean acceleration of gravity $\left(980.665 \text{ cm}/\text{sec}^2\right)$
g	acceleration of grāvity = function (Z)
H_b	pressure scale height at b
H_ρ	density scale height
h	geopotential altitude
m	molecular weight of the atmosphere
$\overline{m}$	average molecular weight from a to b
m_o	molecular weight at the earth's surface
P	atmospheric pressure, (p)
P_i	pressure at the i level
P_{i-1}	pressure at the i-1 level
P_o	pressure at the upper limit of data
PO	observed pressure at 160 000 feet
PS	standard pressure (30° winter, or 15° N: Supplement) at 160 000 feet
R	universal gas constant = 8.314×10^7 ergs mole^{-1} °K^{-1}
T	atmospheric temperature
$\overline{T}$	average temperature between levels a and b
T_m	molecular scale temperature = Tm_o/m
T_o	temperature at the upper limit of data
TO	observed temperature at 160 000 feet
TS	standard temperature (30° winter, 15° N: Supplement) at 160 000 feet
u	W-E wind (+ from west) -- zonal

v	S-N wind (+ from south) -- meridional
x	horizontal tangent distance (+ toward east)
y	horizontal tangent distance (+ toward north)
Z	geometric altitude
ΔZ	change in geometric altitude
γ	C_p/C_v
ρ	atmospheric density
ρ_o	density at the upper limit of data
ρ_{st}	density according to the U.S. Standard Atmosphere, 1962
Φ	latitude
ω	rotational speed of the earth, radians/second
$\left(\frac{\partial T}{\partial x}\right)_p$	temperature gradient in y direction at constant p
$\left(\frac{\partial T}{\partial y}\right)_Z$	temperature gradient in x direction at constant Z
$\left(\frac{\partial T}{\partial y}\right)_Z$	temperature gradient at constant Z in y direction
$\left(\frac{\partial Z}{\partial x}\right)_p$	slope of surface at constant p in x direction
$\left(\frac{\partial Z}{\partial y}\right)_p$	slope of surface at constant p in y direction
$\left(\frac{\partial Z}{\partial x}\right)_\rho$	slope of surface at constant ρ in x direction
$\left(\frac{\partial Z}{\partial y}\right)_\rho$	slope of surface at constant ρ in y direction

DISCUSSION

Arcasondes, Rawinsondes, and Synoptic Weather Conditions at Reentry

Gemini 6 reentry conditions. - A Rawinsonde is a balloon-borne instrument which measures and records values for temperature, relative humidity, and atmospheric pressure. It reaches a maximum altitude of approximately 100 000 feet. Successful Rawinsonde recordings were made for the Gemini 6 reentry on December 16, 1965, at Cape Kennedy (at 1530 G. m. t.), Grand Turk Island (at 1702 G. m. t.), Eleuthera Island (at 1526 G. m. t.), and Grand Bahama Island (at 1525 G. m. t.). The density deviations for these recordings are presented in figure 2. The 8-km isopycnic level (26 000 ft) and the 24-km level of reduced density variability (79 000 ft) are evident in each sounding. (The isopycnic level is explained in appendix A.) The density was 3 to 4 percent less than standard at the surface and 15 to 20 percent greater than standard at 55 000 feet (17 km). Grand Turk Island had the greatest positive variation, while Cape Kennedy had the least at 55 000 feet (17 km). Thus, a negative slope of the density surface existed from Grand Turk to Cape Kennedy at 55 000 feet.

Failure of the primary Nike-Cajun falling-sphere experiment on December 16 at Eglin AFB was apparently related to tracking problems with the FPS-16 radar which were due to inclement weather conditions. The backup Nike-Cajun fired later that afternoon provided the required data between 108 000 and 328 000 feet. All three Arcasondes launched from Eglin AFB were also unsuccessful - a problem also apparently related to the weather. The synoptic weather map for December 16 (fig. 3) shows that Eglin AFB had a N-NW wind at 5 to 8 miles per hour (mph), a complete overcast of stratus clouds, a pressure of 1017 millibars (mb), a temperature of 61° F, a rising pressure (+2 mb in the last 3 hr), a dewpoint of 55° F, and a stationary front just off the coast. While conditions were almost the same at Cape Kennedy, a successful Arcasonde was obtained after one failure. The situation at Grand Turk Island was much better and a successful Arcasonde was obtained on the first attempt.

At Cape Kennedy (at 1645 G. m. t.) and Grand Turk Island (at 1530 G. m. t.) the rockets reached maximum altitudes of 196 000 and 164 000 feet, respectively. The results of these firings are tabulated in 250-m and 1000-ft intervals (tables I and II) and the percentage density deviations from the U. S. Standard Atmosphere (ref. 1) are presented in graphic form in figure 4. Both curves show similar features with minimums at 85 000 feet (26 km) and 135 000 feet (41 km). The extreme negative data point at 120 000 feet (37 km) at Cape Kennedy appears to be questionable. The slope of the constant density surface is negative from Grand Turk Island (GTI) to Kennedy Space Center (KSC) above 100 000 feet (33 km); that is, the density at GTI is greater. The constant density surface is not necessarily parallel to the ground, and usually is not, because of pressure and temperature gradients. Its slope is zero or very small near isopycnics.

The winds measured by the Arcasondes on December 16 are given in figures 5 and 6. In these figures the wind structure for KSC and GTI are nearly identical at 110 000 feet, but are widely divergent at higher altitudes. At 130 000 feet the west (zonal) wind is 40 m/sec higher at KSC than at GTI. At higher altitudes the zonal winds have similar structure, but are 30 m/sec higher at KSC. The thermal wind equation

$$\frac{\partial u}{\partial Z} = \frac{-g}{fT}\left(\frac{\partial T}{\partial y}\right)_p \tag{1}$$

shows that the wind shear ($\partial u/\partial Z$) is proportional to the horizontal temperature gradient ($\partial T/\partial y$). In figures 5 and 6 the winds are interpreted in the following manner. Up to 115 000 feet the atmosphere is colder to the north and warmer to the south of both stations. At this altitude the atmosphere becomes warmer to the north or cooler to the south of GTI, thus causing the wind to decrease with altitude. Because this change does not occur at KSC until 130 000 feet, the result is a warm spot between KSC and GTI or a cold region to the south of GTI at 115 000 feet to 130 000 feet.

The Arcasonde failures at Eglin AFB on December 16 necessitated extrapolating the temperature, pressure, and density data from the Cape Kennedy Arcasonde to Eglin AFB and then extrapolating vertically to 400 000 feet (as described in the following sections on "Vertical Extrapolation Techniques" and "Horizontal Extrapolation Techniques").

Gemini 7 reentry conditions. - Rawinsonde measurements for Gemini 7 were taken on December 18, 1965, at Cape Kennedy (at 1420 G. m. t.), Grand Bahama Island (at 1200 G. m. t.), Eleuthera Island (at 1329 G. m. t.), and Grand Turk Island (at 1604 G. m. t.). The percentage density deviation from the U. S. Standard Atmosphere, 1962, is shown for each in figure 7. The density structure in the lower levels (up to 100 000 ft) did not change significantly from December 16 to December 18. The same features are evident, such as the 8-km isopycnic level, the 17-km maximum, and the 24-km level of reduced variability. The slope of the density surface is negative from Grand Turk to Cape Kennedy at 55 000 feet (17 km); that is, Grand Turk has the greater density. However, the density at this altitude at GTI has decreased 3 percent from the December 16 value.

On December 18 the stationary front that was present during Gemini 6 reentry had moved farther south of the coastline (fig. 8). However, the weather at Eglin AFB had not improved. As shown in figure 8, Eglin AFB had a NE wind at 5 to 8 mph, a complete overcast of stratocumulus and altocumulus with altostratus or nimbostratus clouds, continous rain, pressure of 1019 millibars, temperature of 51° F, rising pressure (+0.7 mb in the last 3 hr), and dewpoint of 48° F. On this day one failure occurred and one partially successful Arcasonde was recorded at Eglin, one successful Arcasonde was fired from Cape Kennedy, and two successful Arcasondes from Grand Turk Island.

The maximum altitude of the rocket at Cape Kennedy (at 1510 G. m. t.) was 180 000 feet, for Grand Turk Island the maximum at 1500 G. m. t. was 177 000 feet, and at 1410 G. m. t. the data extended only to 147 000 feet. Tabulation of the results is contained in tables III to V. The density deviations of these soundings are shown in figure 9. The greatest negative density deviation was obtained at Grand Turk Island (1410 G. m. t.) at approximately 24 kilometers (80 000 ft), but this value appears to be inconsistent. A predominantly negative slope of the density surface is again evident from Grand Turk Island to Cape Kennedy above 120 000 feet (37 km). A 5-percent decrease in density occurred at 130 000 feet (40 km) at Cape Kennedy from December 16 to December 18, as evidenced in figures 4 and 9.

The winds measured by the Arcasondes on December 18 are given in figures 10 and 11. In these figures the wind structure at KSC and at GTI are similar up to 110 000 feet. Above this altitude the zonal (west) winds at GTI decay rapidly until 120 000 feet, while the winds at KSC continue to increase to 115 000 feet, where they decrease a small amount. Above 120 000 feet similar features occur at a number of altitudes, although the KSC winds are greater by 40 m/sec up to 140 000 feet, and 15 m/sec up to 180 000 feet. The similarity in the observed wind shears indicates that almost identical temperature gradients occurred at GTI and KSC, except near 110 000 feet where the atmosphere becomes warmer to the north or cooler to the south of GTI.

Vertical Extrapolation Techniques

To extend the Arcasonde meteorological rocket data to an upper limit of 400 000 feet, a temperature profile is constructed above 160 000 feet on the basis of the temperature and pressure at that altitude. (All altitudes in this section are given in geometric units; however, their geopotential equivalents are used in the final computations.) The method is based, up to 300 000 feet, upon the upper atmosphere extension technique (personal communication from John Pohle, Feb. 1966) used at Patrick AFB. In this extrapolation, the last 100 000 feet (from 300 000 to 400 000 ft) of the Air Force program were not used, because this program always produced a positive percentage density deviation and did not present values for the temperature, pressure, or speed of sound. The pressure, density, and percentage density deviation (ref. 1) are calculated from 160 000 to 400 000 feet on the basis of the latest observed data, the temperature structure, the hydrostatic equation

$$\frac{\partial P}{\partial Z} = -\rho g \tag{2}$$

and the equation of state

$$P = \frac{\rho RT}{m} \tag{3}$$

A discussion of hydrostatic atmospheres is in appendix B.

All observed data up to 160 000 feet are read into the computer. The applicable U.S. Standard Atmosphere Supplement, 1966 (in press) (30° N winter or 15° N annual) is called up from the subroutine. At 160 000 feet the observed pressure and temperature are compared with the reference pressure and temperature.

If: PO = PS

Condition	Result
TO = TS	Computed temperature (T) = TS
TO > TS	T = TS at 216 k ft
	T = TS - (TO - TS) at 258 k ft
	T = TS at 300 k ft
TO < TS	T = TS at 216 k ft
	T = TS - (TO - TS) at 258 k ft
	T = TS at 300 k ft

If: PO > PS

TO = TS	T = TS up to 216 k ft
	T = TS - 5° K at 258 k ft
	T = TS at 300 k ft
TO > TS	T = TS at 216 k ft
	T = TS - 2(TO - TS) at 258 k ft
	T = TS at 300 k ft
TO < TS	T = TS at 216 k ft

Condition	Result
	If: PO < PS
TO = TS	T = TS up to 216 k ft
	T = TS + 5° K at 258 k ft
	T = TS at 300 k ft
TO > TS	T = TS at 216 k ft
	T = TS + (TO - TS) at 258 k ft
	T = TS at 300 k ft
TO < TS	T = TS at 216 k ft
	T = TS - 2(TO - TS) at 258 k ft
	T = TS at 300 k ft

Between 300 000 and 400 000 feet the temperature is set equal to the reference values for molecular scale temperature.

After the completion of the temperature profile, the pressure, density, and speed of sound are computed using the following equations

$$P_i = P_{i-1} \exp\left(\frac{-\Delta Z \, mg}{RT}\right) \tag{4}$$

$$\rho = \frac{Pm}{RT} \tag{5}$$

$$c_s = \left(\frac{\gamma R}{m_o} T_m\right)^{1/2} \tag{6}$$

Next, the percentage density deviation from the U.S. Standard Atmosphere, 1962 (ref. 1) is computed according to the equation

$$\text{Percent } \rho \text{ deviation} = \left(\frac{\rho - \rho_{st}}{\rho_{st}}\right) \times 100 \tag{7}$$

Finally, the altitude, reference temperature, computed temperature, reference pressure, computed pressure, density, speed of sound, and the percentage density deviation are listed from the base of the data input to 400 000 feet in 1000-ft (geometric) intervals.

Horizontal Extrapolation Techniques

Because the spacecraft reentry ground track and the location of high-altitude meteorological sounding-rocket stations do not often coincide, the measured quantities (temperature, density, and pressure) must be extrapolated by use of the measured winds, the thermal wind equation, the geostrophic wind equation, and the mass wind equation. These equations assume the horizontal pressure gradient to be proportional to the wind and density of the atmosphere. This assumption is known as the geostrophic wind condition and is expressed in orthogonal coordinates as

$$\frac{\partial P}{\partial y} = -\rho u f \tag{8}$$

$$\frac{\partial P}{\partial x} = \rho v f \tag{9}$$

Through equations (8) and (9), the hydrostatic equation (2), and the equation of state (3), the expressions for the slope of a constant density surface - equations (10) and (11) - may be derived

$$\left(\frac{\partial Z}{\partial y}\right)_{\rho} = \frac{f}{g}\left[H_{\rho}\frac{\partial u}{\partial Z} - u\right] \tag{10}$$

$$\left(\frac{\partial Z}{\partial x}\right)_{\rho} = \frac{f}{g}\left[v - H_{\rho}\frac{\partial v}{\partial Z}\right] \tag{11}$$

(These equations are derived in detail in ref. 2.)

Likewise, equations (2), (3), (8), and (9) may be used to obtain equations (12) and (13) - the slope of a constant pressure surface

$$\left(\frac{\partial Z}{\partial y}\right)_p = \frac{-fu}{g} \tag{12}$$

$$\left(\frac{\partial Z}{\partial x}\right)_p = \frac{fv}{g} \tag{13}$$

(A derivation of these equations is available in ref. 3.)

The horizontal temperature gradient, equations (14) and (15), may be obtained from the same assumptions, giving

$$\left(\frac{\partial T}{\partial y}\right)_Z = \frac{-fum}{R} + \frac{fT}{g}\left[\frac{u}{H_\rho} - \frac{\partial u}{\partial Z}\right] \tag{14}$$

$$\left(\frac{\partial T}{\partial x}\right)_Z = \frac{fvm}{R} + \frac{fT}{g}\left[\frac{\partial v}{\partial Z} - \frac{v}{H_\rho}\right] \tag{15}$$

(A derivation of these equations is also available in ref. 3.)

The preceding six equations, when used with the measured data and the distance from the sounding rocket to the desired extrapolation point, give the change of temperature and deviation in altitude of the ρ and p surfaces. Thus by calculating ΔT, $(\Delta Z)_\rho$, and $(\Delta Z)_p$ for each data point given by the meteorological rocket, a reliable estimate may be obtained of the atmospheric structure some distance from the atmospheric sounding. The reliability of this technique was verified by extrapolating the Rawinsonde data from Cape Kennedy to Eleuthera, then extrapolating the Rawinsonde data from Grand Turk Island to Eleuthera, and averaging the values of density, pressure, and temperature to account for curvature of the $\nabla_H \rho$, $\nabla_H p$, and $\nabla_H T$ fields. The calculated model was then compared to the Rawinsonde data at Eleuthera. Similar extrapolation tests were also made from Grand Bahama Island by extrapolating from Cape Kennedy and Grand Turk Island (fig. 12). The tests all agreed within 3 percent of the measured values. Open-ended extrapolations (that is, from Cape Kennedy to Eglin AFB) are not expected to be as reliable, however, without having a station to the west of Eglin AFB. Both stations are necessary in order to account for the curvature of the density, pressure, and temperature fields.

Another significant fact is that the equations used here are based on the importance of the coriolis force in the atmospheric motions. Thus, these equations may be used only for mid-latitude and low-latitude extrapolations.

Equations (10) to (15) have been programed for the IBM 7094 in the Fortran II language for use in horizontal extrapolations of Arcasondes that are fired in support of manned missions. The input and output parameters are described in appendix C.

Arcasonde Extrapolations to 400 000 Feet

The Arcasonde data (described in the section on "Arcasondes, Rawinsondes, and Synoptic Weather Conditions at Reentry") for Cape Kennedy and Grand Turk Island were extrapolated vertically to 400 000 feet by use of the techniques already given (in the section on "Vertical Extrapolation Techniques").

The two soundings made at Cape Kennedy (December 16 at 1645 G. m. t. and December 18 at 1510 G. m. t., for Gemini 6 and Gemini 7, respectively) were extended by use of the 30° N winter reference atmosphere in the U. S. Standard Atmosphere Supplement, 1966 (in press). A plot of the density structure of these two model atmospheres is given in figures 13 and 14. Both figures show similar structure when compared to the 30° N winter atmosphere, which is also included in the figures. The differences between figures 13 and 14 are caused by the pressure and temperature recorded by the respective Arcasonde data at 160 000 feet. In each case, near-zero density deviations are found near 79 000 feet (24 km) and near 164 000 feet (50 km), while the zero-density deviations on the extrapolations have moved relative to the 30° N winter model from 279 000 feet (85 km) up to 312 000 feet (95 km) in figure 13, and up to 338 000 feet (130 km) in figure 14. Both models were as much as 10 percent greater than the 30° N winter in the region up to 262 000 feet (80 km).

The soundings at Grand Turk Island on December 16 at 1530 G. m. t. and on December 18 at 1500 G. m. t., for Gemini 6 and Gemini 7, respectively, were extended by using the 15° N annual reference atmosphere in the U. S. Standard Atmosphere Supplement (in press). A plot of the density structure of these two model atmospheres is given in figures 15 and 16. The information in both figures shows good correlation to that in the 15° N model (which is included). These two soundings do not show the degree of day-to-day variability that was noted at Cape Kennedy in figures 13 and 14.

The Arcasonde data already described were extrapolated horizontally to the reentry ground tracks (fig. 1) and then extrapolated vertically to 400 000 feet (by means of the respective techniques discussed in the preceding report sections). The resultant atmospheric density cross sections for Gemini 6 and Gemini 7 are shown in figures 17 and 18. The cross section extends westward to E6 for Gemini 6, and to F7 for Gemini 7 (fig. 1). Further data extrapolation eastward without sounding-rocket stations on the coast of Texas would have been too inaccurate for use. The structure of the cross sections is almost identical up to 150 000 feet. Above that altitude the difference between the 30° N winter atmosphere and the 15° N annual atmosphere becomes predominant. At 300 000 feet (92 km) the Gemini 6 reentry corridor is near density given in the U. S. Standard Atmosphere, 1962; the Gemini 7 reentry corridor is some 20 percent less than the standard. This difference is probably due to the fact that the Gemini 7 reentry occurred 1 hour 20 minutes earlier in the day than that of the Gemini 6.

Nike-Cajun Falling-Sphere Data for Gemini 6

Two Nike-Cajun rockets, identical to those used by the University of Michigan at Kwajalein (ref. 4), were fired from Eglin AFB on December 16, 1965. The primary purpose of the experiment was to measure density as a function of altitude up to 300 000 feet. Inflatable spheres of aluminized mylar (0.015 mm in thickness) with a mass of 50.554 grams and a diameter of 66 centimeters (ref. 4; and personal communication from J. W. Peterson, Feb. 1966) were deployed and inflated with isopentane gas on the ascending portion of the trajectory. The spheres were tracked by FPS-16 radar. No accelerometers or telemetry were required since the density could be found by processing the radar data. When this payload was designed, three spheres were included because sphere deployment and inflation problems had been prevalent on earlier flights. This particular system had demonstrated good reliability by the time of the experiment, however. The only reason that the second and third spheres were left in the payload was to avoid changing the ballistics of the Nike-Cajun. The fact that the payload was unchanged proved to be very fortunate since problems in radar acquisition developed due to inclement weather. In the first firing, none of the three spheres were acquired. In the backup firing, one sphere was tracked from 400 000 feet down to 100 000 feet where sphere deflation occurred at approximately 18 minutes after launch. No ascent data were obtained. The rockets were fired at an elevation of 80° and, according to the ballistic data, the result should have been an apogee of 375 000 feet. The higher-than-planned apogee of 400 000 feet could also have contributed to the radar acquisition problem. In the only successful measurement, density was measured from 100 kilometers down to 31 kilometers and winds were obtained from 70 kilometers down to 31 kilometers. Pressure and temperature were obtained by integrating the observed density, as follows:

$$P(Z) = P_o + \int \rho \ g \ dZ \tag{16}$$

$$T(Z) = \frac{\rho_o T_o}{\rho(Z)} + \frac{m}{R\rho(Z)} \int \rho \ (z) g \ dz \tag{17}$$

The results of this sounding are given in table VI.

As already mentioned, the numerous Arcasonde attempts at Eglin AFB yielded no data on December 16 and only wind data on December 18. Comparison of the Cape Kennedy Arcasonde at 1645 G.m.t. and the Eglin AFB falling sphere at 1922 G.m.t. (fig. 19) showed remarkable agreement in the measured wind velocity. The difference in local time between the two stations, 2 hours, does not appear to be responsible for the 15 m/sec higher winds measured by the falling sphere (fig. 19), since a similar effect was noted on December 18 with less than 36 minutes difference in local times (figs. 20 and 21) between the two stations. Both the meridional and zonal winds, as measured by the two systems, agree and show similar structure to a high degree of detail (fig. 19). The December 18 Arcasonde winds from Cape Kennedy and Eglin AFB are compared in figures 20 and 21. Again, excellent agreement is observed. At

135 000 feet both soundings (1405 and 1510 G. m. t.) at Cape Kennedy show 15 to 20 m/sec less west (zonal) wind speed than Eglin AFB (1516 G. m. t.).

West winds at Cape Kennedy are shown to be stronger below and weaker above 120 000 feet than at Eglin AFB (figs. 15 to 17). Also the south winds (meridional) near 150 000 feet appear to be stronger at Eglin AFB than at Cape Kennedy (figs. 15 to 17). Thus the observed differences between the two wind-measuring techniques - Arcasondes and falling spheres - appear to be due to large-scale high-altitude synoptic weather systems rather than to the measuring techniques themselves.

In figure 22 is shown the density obtained from tracking the passive-falling sphere at Eglin AFB, and also the temperature structure as deduced from the density data by using equation (17). Data from a Rawinsonde for Eglin AFB at 18 hours G. m. t. on December 16 are included up to 100 000 feet along with the temperature structure (ref. 1) and the 30° N winter atmosphere (from the U. S. Standard Atmosphere Supplement, 1966 - in press). The most significant difference between the falling sphere and the standard atmosphere is that the stratopause (160 000 ft, 50 km) temperature is 35° K greater than that in the standards. This difference is a consequence of the anomalously low density, reportedly below 180 000 feet (55 km). Also the temperature at 230 000 feet (70 km) is some 28° K less than standard because of the 30-percent increase in density down through the transonic region where the sphere's velocity changes from hypersonic to subsonic. Reasonable agreement is found between the temperatures of the standard and the falling sphere at 108 000 feet (33 km), 131 000 feet (40 km), and near 190 000 feet (58 km). Above 230 000 feet (70 km) both density and temperature appear reasonable. While data scatter increases in this region, the density structure seems to show the 90-km isopycnic level (zero-percent deviation from standard) and reasonable temperature structure up to 328 000 feet (100 km).

The Arcasonde data obtained at Cape Kennedy (1645 G. m. t.) were extrapolated horizontally to Eglin AFB by using the information on winds (fig. 19) and the method already reported in the relevant report section. These data were then extrapolated vertically by means of the method described in the report section on that subject. The extrapolations and the falling-sphere densities are compared in figure 23. As can be seen in this figure, the horizontal extrapolation of the Rawinsonde at Cape Kennedy to Eglin AFB is comparable within 3 percent to the Eglin Rawinsonde. The stationary frontal system (fig. 3) between the two stations probably caused most of this error; for this is a region of instability, and the horizontal extrapolation technique is based on a stable, hydrostatic, and geostrophic atmosphere. At altitudes higher than 70 000 feet (21 km), the effect of the front will become negligible. This comparison, under adverse conditions in the troposphere, again verifies that these horizontal extrapolations in the mesosphere should be accurate to within 3 percent or less.

The higher regions of both the extrapolated Arcasonde and the falling sphere show similar features at 128 000 feet (39 km) and at 154 000 feet (47 km), although the falling sphere detected a less dense atmosphere. The falling-sphere data appear anomalously greater than standard from 187 000 feet (57 km) to 230 000 feet (70 km). Since the falling-sphere sounding occurred some 2 hours later in local time (1: 30 p. m.) than the Cape Kennedy Arcasonde (11: 30 a. m.), solar heating near 160 000 feet caused the falling sphere to experience a less dense, higher temperature atmosphere than did the Arcasonde. This increase in temperature also increases the density-scale height, which in turn causes the density in the atmosphere to be increased at some greater height. As a result, the density became greater than standard above an altitude of 180 000 feet (52 km). To verify this hypothesis, a vertical extrapolation was made of the falling-sphere data from 160 000 feet. The data in figure 23 indicate that the structure of the falling sphere can, to a degree, be explained in this way; however, the density in the region below the transonic discontinuity is probably high by 10 or 12 percent.

Above the transonic region, the Arcasonde extrapolation and the falling-sphere data agree quite well (fig. 23), with both going from negative to positive at 295 000 feet (90 km). Since other soundings made with this type of falling sphere consistently indicate an increase in density when the sphere falls through the transonic region (ref. 4), and consistently derive temperatures 10° to 30° K higher than standard at 164 000 feet (50 km), the opinion is that the local time difference is not the only explanation of the observed high temperature at this altitude. The great variability of drag is a probable source of error in the analysis of the radar data. However, the falling sphere is believed to have drag coefficients that are reliable to within 2 percent (ref. 4) in the region near 160 000 feet (50 km).

In the region of reasonable density correlation (above the transonic region) the drag coefficients are reportedly not as accurate as at lower altitudes. The Arcasonde temperatures are not believed to be the cause of the discrepancy, since they have accuracies of ± 3 percent at 160 000 feet (50 km). If infrared radiation did affect the mission, smaller horizontal density gradients will be be experienced in the summer, since the 30° N summer atmosphere is similar to the 15° N annual.

CONCLUSIONS

No definite statement can be made about the relative reliability of the two atmospheric measuring techniques - falling spheres and Arcasondes - on the basis of one comparison. This comparison does, however, indicate that:

1. Remarkable agreements were noted in the measured wind with the two systems.

2. Reasonable agreement was shown in the density structure above 70 kilometers with the falling sphere and the extrapolation of the Arcasonde.

3. Some differences between the density structure as measured by the two systems below 70 kilometers may be attributable to solar heating between times of the Arcasonde firing and the Nike-Cajun firing. However, the agreement in the winds, especially the meridional components, does not substantiate this possibility.

4. Large variations in density along the Gemini reentry ground track are due primarily to diurnal, latitudinal, and seasonal effects. Thus, on the typical Gemini mission, smaller horizontal density gradients will be experienced in the summer, since the 30° N summer atmosphere is similar to the 15° N annual.

Manned Spacecraft Center
National Aeronautics and Space Administration
Houston, Texas, October 17, 1966
981-89-0000-72

APPENDIX A

ISOPYCNIC LEVELS

The term "isopycnic" means constant density. An isopycnic level is an altitude at which the density tends to remain constant regardless of meteorological changes that go on about it. The isopycnic level is a consequence of the equations that describe an atmosphere in a gravitational field.

Regions of minimum density variability are termed "isopycnic levels" only when they occur on a worldwide basis throughout each year. Such regions of minimum density variability occur near 8, 24, and 90 kilometers. The regions of maximum density variability occur at the surface, at 16 kilometers, and 70 kilometers. Of these three levels of maximum variability, 70 kilometers has by far the largest amplitude.

The wind field also tends to show certain characteristics associated with the density field:

a. Isopycnic levels tend to occur just below maximums in wind.

b. Regions of maximum variability of density occur just above maximums in wind.

Other information about the density structure of the earth's atmosphere can be summarized as follows:

a. The region of the mesodecline (50 to 80 km) is the region of the greatest diurnal and seasonal variability up to the mesopause (80 km).

b. The density in polar regions has much greater variability than do low-latitude densities, both on a seasonal and diurnal basis.

c. The maximum diurnal variation of density above 50 kilometers (up to the mesopause) occurs north of 28-38° N, and is on the order of ±10 percent, being positive during the day and negative at night. Up to 25 kilometers the diurnal variation is ±1.2 percent.

d. Densities are more dependent upon season and latitude than on local time or solar activity up to 120 kilometers. However, the diurnal variation becomes predominant at higher altitudes.

APPENDIX B

HYDROSTATIC ATMOSPHERES

The hydrostatic equation is the basic equation (B1) describing the rate of change of pressure in the lower region of the atmosphere (up to about 550 km). In this equation, which relates the vertical gradient of pressure to the local value of density and gravity, the direction z is defined as an extension of the line perpendicular to the equipotential surface at sea level, with positive being away from the center of the earth.

$$\frac{\partial P}{\partial Z} = -\rho g \tag{B1}$$

If density were known as a function of height, equation (B1) would be integrable. However, temperature, not density, is usually the known function in an atmosphere. For this reason the equation of state (B2)

$$\rho = \frac{Pm}{RT} \tag{B2}$$

is substituted into (B1), yielding

$$\frac{\partial P}{P} = \frac{-mg}{RT} \partial Z \tag{B3}$$

Integrating equation (B3) gives

$$\int_a^b \left[\frac{dP}{P}\right] = \int_a^b \frac{-mg}{RT}\, dZ \tag{B4}$$

Since $\partial T/\partial Z$ varies slowly as a function of Z, then $\overline{T}$ (average temperature) from a to b may be used in place of T, if ab is a small increment. Thus $\overline{T}$ may be brought outside the integral. Likewise, m varies slowly with height and may be replaced by $\bar{m}$ (average value) for the increment

$$-\ln\left[\frac{P_a}{P_b}\right] = \frac{-\bar{m}}{R\bar{T}} \int_a^b g\, dZ \tag{B5}$$

If geopotential height H is used, then

$$g\, dZ = G\, dH \tag{B6}$$

Equation (B6) may be substituted in (B5) giving

$$\ln \frac{P_a}{P_b} = \frac{\bar{m}G\, \Delta H_{ab}}{R\bar{T}} \tag{B7}$$

By rearranging (B7), then

$$P_b = P_a \exp\left\{\frac{-\bar{m}G\, \Delta H_{ab}}{R\bar{T}}\right\} \tag{B8}$$

For isothermal ($\partial T/\partial z = 0$) and homogeneous regions of the atmosphere $\bar{m} = m$ and $\bar{T} = T$, giving

$$P_b = P_a \exp\left\{\frac{-mG\, \Delta H_{ab}}{RT}\right\} \tag{B9}$$

For a region having a constant (nonzero) vertical gradient of temperature, another form is useful. Beginning with (B4) the following equation is substituted for T

$$T = T_a + \left(\frac{\partial T}{\partial H}\right) H \tag{B10}$$

in which H is geopotential altitude starting at point a (positive upward). As a result

$$\int_a^b \frac{dP}{P} = -\int_a^b \frac{mg\,dz}{R\left[T_a + \left(\frac{\partial T}{\partial H}\right) H\right]} \tag{B11}$$

Since m may be replaced by $\overline{m}$, g dz may be replaced by G dH, and $\partial T/\partial H$ = constant from z = a to z = b, then

$$-\ln \frac{P_a}{P_b} = \frac{-\overline{m}G}{R\,\frac{\partial T}{\partial H}} \left\{ \ln \left[T_a + \left(\frac{\partial T}{\partial H}\right) H\right] \right\}_a^b \tag{B12}$$

but H was assumed to start at a, H = 0 at a, and $H = H_b$ at b, giving

$$-\ln \frac{P_a}{P_b} = \frac{-\overline{m}G}{R\left(\frac{\partial T}{\partial H}\right)} \ln \left\{ \frac{T_a + \frac{\partial T}{\partial H} H_b}{T_a} \right\} \tag{B13}$$

However, (B10) gives

$$T_b = T_a + \left(\frac{\partial T}{\partial H}\right) H_b$$

so

$$\ln \frac{P_b}{P_a} = \frac{-\overline{m}G}{R\left(\frac{\partial T}{\partial H}\right)} \ln \left(\frac{T_b}{T_a}\right) \tag{B14}$$

Rearranged, the equation becomes

$$P_b = P_a \left(\frac{T_b}{T_a} \right)^{\frac{-\overline{m}G}{R\left(\frac{\partial T}{\partial H}\right)}} \tag{B15}$$

This equation may be used to calculate pressure as a function of temperature and height for any nonzero lapse rate of temperature region of the atmosphere.

APPENDIX C

HORIZONTAL EXTRAPOLATION COMPUTER PROGRAM

The equations for mass wind, geostrophic wind, and thermal wind have been used in the following computer program in order to extrapolate Arcasonde data by means of the measured winds, wind shears, vertical density gradient, and vertical pressure gradient. Through this program, Arcasonde data will be useful some distance from where the sounding occurred. The input parameters, output parameters, and a Fortran II source printout are described in the following:

Card no. 1 contains the altitude (ft), temperature ($^{\circ}$K), and pressure (mb). The last card of type 1 has a nonzero number in columns 25 to 27.

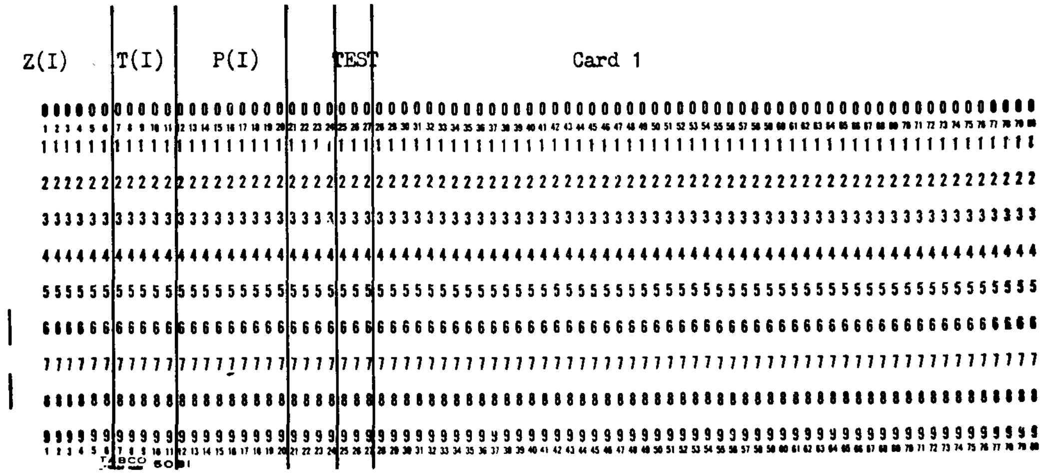
Card no. 2 contains the altitude (ft), wind direction (deg), and wind speed (knots). The last card of type 2 has a nonzero number in columns 20 to 22.

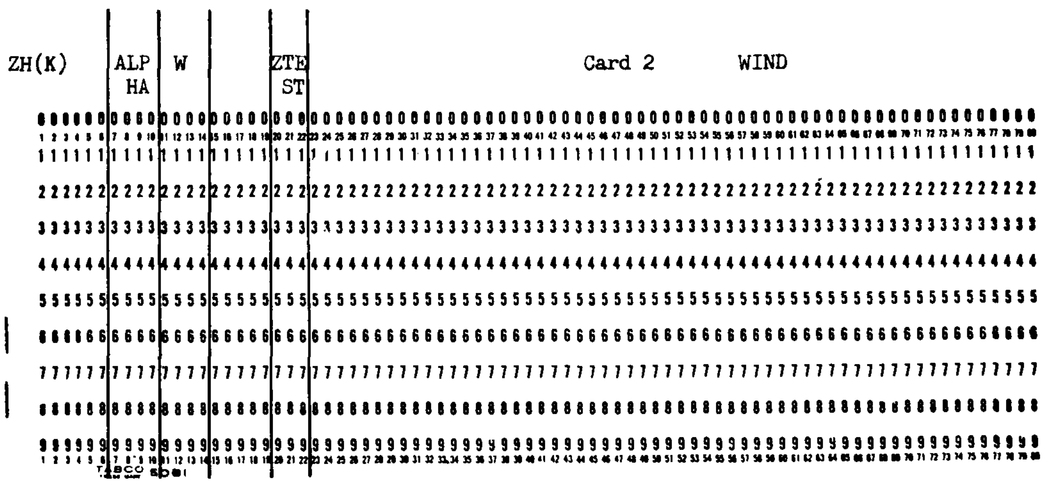
Card no. 3 contains the distance east, distance north, and latitude. Distance is in nautical miles and latitude is in degrees. The last card of type 3 has a nonzero number in columns 36 to 45.

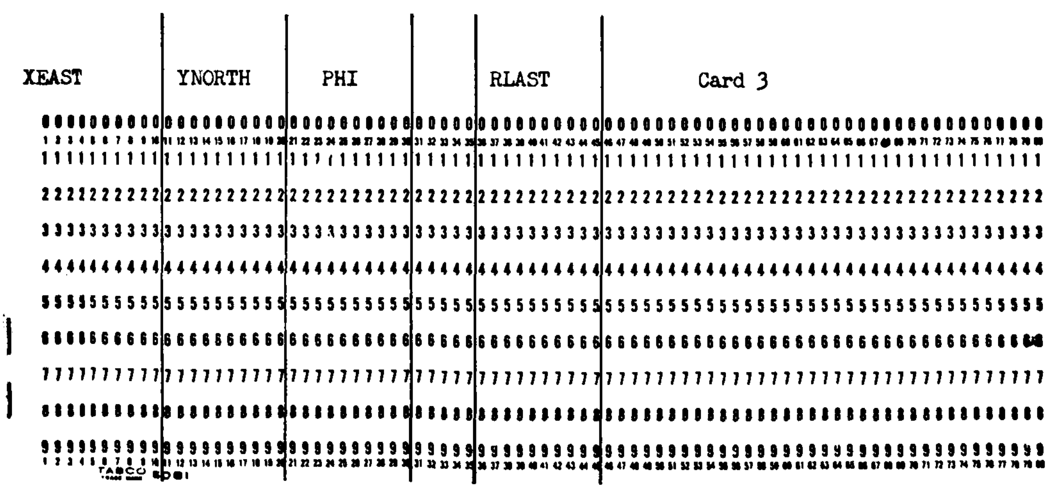
Sample input cards of these types are included here so that the fields for the different quantities may be readily distinguished. A printup of the computer source program and a legend of the output form follow.

OUTPUT QUANTITIES AND UNITS

Z	Density	Percent	$(\partial Z/\partial y)_\rho$	$(\partial Z/\partial x)_\rho$	Pressure	Percent P	$(\partial Z/\partial y)_P$	$(\partial Z/\partial x)_P$	Temperature	Speed of sound	West wind	South wind
ft $\times 10^{-3}$	gm/cc	Deviation from 1962 standard	m/m	m/m	mb	Deviation from 1962 standard	m/m	m/m	°K	m/sec	m/sec	m/sec


Z(I)
T(I)
P(I)
TEST
Card 1


ZH(K)
ALP HA
W
ZTE ST
Card 2
WIND


XEAST
YNORTH
PHI
RLAST
Card 3

GEMINI REENTRY EXTRAPOLATICN USING THE MASS WIND EQUATION FOR DENSITY

```
      DIMENSION Z(100),T(100),P(100),ZH(100),U(100),V(100)
     1,ANSW(8)
      G0=9.79324
      R=2.8704E+02
      RE=6344.206E+03
      C=3.14159265/180.
      R0=8.314E+07
  107 I=1
    1 READ INPUT TAPE 5,2,Z(I),T(I),P(I),TEST
    2 FORMAT (F6.0,F5.1,F9.1,4X,F3.0)
      Z(I)=Z(I)/3.281
      I=I+1
      IF (TEST) 4,1,4
    4 K=1
    5 READ INPUT TAPE 5,6, ZH(K),ALPHA,W,ZTEST
    6 FORMAT (F6.0,F4.1,F4.0,5X,F3.0)
      U(K)=-W*SINF(ALPHA*C)/1.94
      V(K)=-W*COSF(ALPHA*C)/1.94
      ZH(K)=ZH(K)/3.281
      K=K+1
      IF (ZTEST) 7,5,7
C XEAST AND YNORTH ARE IN NAUTICAL MILES FROM ROCKETSONDE
    7 K=K-1
      I=I-1
   97 READ INPUT TAPE 5,8,XEAST,YNORTH,PHI,RLAST
    8 FORMAT (3F10.1,5X,F10.1)
      WRITE OUTPUT TAPE 6,330
  330 FORMAT (1H1)
      XEAST=XEAST*111100.0/59.96
      YNORTH=YNORTH*111100.0/59.96
      FC=2.0*7.292E-05*SINF(PHI*C)
      DO 10 J=2,K
      G=G0*RE*RE/((RE+ZH(J))**2)
      DO 11 N=1,I
      IF (ZH(J)-Z(N)) 13,12,14
   12 TEMP=T(N)
      GO TO 16
   13 N=N-1
      GO TO 15
   14 CONTINUE
   11 CONTINUE
      IF (RLAST) 107,97,107
   15 TEMP=T(N)+(T(N)-T(N+1))/(Z(N)-Z(N+1))*(ZH(J)-Z(N))
   16 DTDZ=(T(N+1)-T(N-1))/(Z(N+1)-Z(N-1))
      DUDZ=(U(J+1)-U(J-1))/(ZH(J+1)-ZH(J-1))
      DVDZ=(V(J+1)-V(J-1))/(ZH(J+1)-ZH(J-1))
      HRHO=TEMP/((G/R)+DTDZ)
      SLOPEN=-(FC/G)*(U(J)-HRHO*DUDZ)
      SLOPEE=(FC/G)*(V(J)-HRHO*DVDZ)
      DTDY=-(FC*U(J))/R+FC*TEMP/G*(U(J)/HRHO-DUDZ)
      DTDX=(FC*V(J))/R+FC*TEMP/G*(DVDZ-V(J)/HRHO)
      DZDYP=-FC*U(J)/G
      DZDXP=FC*V(J)/G
      DZY=SLOPEN*YNORTH
      DZX=SLOPEE*XEAST
```

GEMINI REENTRY EXTRAPOLATION USING THE MASS WIND EQUATION FOR DENSITY

```
      DZ=DZY+DZX
      ZNEWZ=ZH(J)-DZ
      DO 21 IQ=1,I
      IF (ZNEWZ-Z(IQ)) 23,22,24
   22 TNEW=T(IQ)
      GO TO 26
   23 IQ=IQ-1
      GO TO 25
   24 CONTINUE
   21 CONTINUE
      IF (RLAST) 107,97,107
   25 DTDQ=(T(IQ+1)-T(IQ-1))/(Z(IQ+1)-Z(IQ-1))
      TNEW=T(IQ)+DTDQ*(ZNEWZ-Z(IQ))
   26 TBAR=(TNEW+T(IQ))/2.0
      G=GO*RE*RE/((RE+ZNEWZ)**2)
      PR=P(IQ)*EXPF(-G/(R*TBAR)*(ZNEWZ-Z(IQ)))
      RHO=PR*28.964E+03/(RO*TNEW)
      TNEW=TEMP+DTDY*YNORTH+DTDX*XEAST
      PR=RHO*RO*TNEW/28.964E+03
      CALL ATMOS3 (ZH(J),500000.0,ANSW)
      PER=(RHO-(ANSW(3)*1.225E-03))/(ANSW(3)*1.225E-03)*100.
      PERP=(PR-(ANSW(1)*1013.25))/(ANSW(1)*1013.25)*100.0
      ZQ=ZH(J)*3.281E-03
      SCC=32.81*SQRTF(1.4*8.31432*TNEW/28.964)*SQRTF(10.0)
   10 WRITE OUTPUT TAPE 6,30,ZQ,RHO,PER,SLOPEN,SLOPEE,PR,PERP,DZDYP,DZDX
     1P,TNEW,SCC,U(J),V(J)
   30 FORMAT (1X,F5.1,1PE11.3,0PF4.1,5P2F6.2,1PE11.3,0PF4.1,5P2F6.2,
     10PF8.2,0PF10.1,0P2F7.1)
      IF (RLAST) 107,97,107
      END(1,0,0,0,0,0,1,0,0,1,0,0,0,0,0)
```

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TABLE I. - ARCASONDE DATA FROM CAPE KENNEDY, DEC. 16, 1965,

AT 1645 G. m. t.

Test no. 7402

Altitude, m	Temperature, °K	Pressure, mb	Density, gm/m^3	Velocity of sound, knots
24079.	213.25	29.0000	47.3764	568.89
24250.	213.71	28.2287	46.0162	569.51
24500.	214.39	27.1379	44.0981	570.41
24750.	215.07	26.0893	42.2604	571.31
25000.	215.75	25.0812	40.4996	572.21
25250.	215.95	24.1196	33.9108	572.48
25500.	216.15	23.1948	37.3843	572.74
25750.	216.35	22.3055	35.9177	573.01
26000.	216.55	21.4503	34.5087	573.27
26250.	217.32	20.6354	33.0793	574.30
26500.	218.10	19.8514	31.7094	575.32
26750.	218.87	19.0972	30.3967	576.34
27000.	219.65	18.3716	29.1387	577.36
27250.	219.95	17.6805	28.0043	577.76
27500.	220.25	17.0154	26.9142	578.15
27750.	220.55	16.3754	25.8665	578.55
28000.	220.85	15.7594	24.8597	578.94
28250.	221.25	15.1704	23.8873	579.46
28500.	221.65	14.6035	22.9531	579.99
28750.	222.05	14.0577	22.0555	580.51
29000.	222.45	13.5323	21.1931	581.03
29250.	222.57	13.0291	20.3935	581.20
29500.	222.70	12.5445	19.6240	581.36
29750.	222.82	12.0760	18.8837	581.52
30000.	222.95	11.6289	18.1712	581.68
30250.	223.22	11.1961	17.4765	582.04
30500.	223.50	10.7832	16.8084	582.40
30750.	223.77	10.3838	16.1658	582.76
31000.	224.05	9.9991	15.5478	583.12
31250.	224.95	9.6325	14.9179	584.29
31500.	225.85	9.2794	14.3138	585.46
31750.	226.75	8.9393	13.7344	586.62
32000.	227.65	8.6116	13.1786	587.78
32250.	229.10	8.3023	12.6250	589.65
32500.	230.55	8.0042	12.0950	591.52
32750.	232.00	7.7167	11.5878	593.37
33000.	233.45	7.4396	11.1023	595.22
33250.	234.37	7.1778	10.6693	596.40
33500.	235.30	6.9253	10.2534	597.58
33750.	236.22	6.6816	9.8539	598.75
34000.	237.15	6.4464	9.4700	599.92
34250.	238.40	6.2237	9.0949	601.50
34500.	239.65	6.0087	8.7349	603.08
34750.	240.90	5.8011	8.3893	604.65
35000.	242.15	5.6006	8.0576	606.21
35250.	243.22	5.4108	7.7501	607.56
35500.	244.30	5.2274	7.4545	608.90
35750.	245.37	5.0502	7.1703	610.24
36000.	246.45	4.8791	6.8970	611.57

TABLE I. - ARCASONDE DATA FROM CAPE KENNEDY, DEC. 16, 1965,

AT 1645 G. m. t. - Continued

Test no. 7402

Altitude, m	Temperature, °K	Pressure, mb	Density, gm/m^3	Velocity of sound, knots
36250.	247.47	4.7165	6.6396	612.84
36500.	248.50	4.5593	6.3919	614.11
36750.	249.52	4.4074	6.1535	615.38
37000.	250.55	4.2606	5.9242	616.64
37250.	253.85	4.1233	5.6588	620.69
37500.	257.15	3.9905	5.4063	624.71
37750.	260.45	3.8620	5.1659	628.70
38000.	263.75	3.7376	4.9369	632.67
38250.	263.45	3.6200	4.7870	632.31
38500.	263.15	3.5060	4.6416	631.95
38750.	262.85	3.3957	4.5006	631.59
39000.	262.55	3.2888	4.3639	631.23
39250.	262.87	3.1853	4.2214	631.62
39500.	263.20	3.0851	4.0836	632.01
39750.	263.52	2.9881	3.9502	632.40
40000.	263.85	2.8940	3.8212	632.79
40250.	263.80	2.8032	3.7020	632.73
40500.	263.75	2.7152	3.5865	632.67
40750.	263.70	2.6300	3.4746	632.61
41000.	263.65	2.5475	3.3662	632.55
41250.	263.37	2.4673	3.2637	632.22
41500.	263.10	2.3897	3.1643	631.89
41750.	262.82	2.3146	3.0680	631.56
42000.	262.55	2.2418	2.9746	631.23
42250.	262.82	2.1713	2.8781	631.56
42500.	263.10	2.1030	2.7847	631.89
42750.	263.37	2.0369	2.6943	632.22
43000.	263.65	1.9728	2.6069	632.55
43250.	264.15	1.9112	2.5206	633.15
43500.	264.65	1.8515	2.4372	633.75
43750.	265.15	1.7936	2.3566	634.35
44000.	265.65	1.7375	2.2787	634.95
44250.	266.65	1.6839	2.2000	636.14
44500.	267.65	1.6318	2.1240	637.33
44750.	268.65	1.5814	2.0507	638.52
45000.	269.65	1.5325	1.9800	639.71
45250.	270.17	1.4857	1.9158	640.33
45500.	270.70	1.4403	1.8537	640.96
45750.	271.22	1.3963	1.7936	641.58
46000.	271.75	1.3537	1.7354	642.20
46250.	271.80	1.3125	1.6823	642.26
46500.	271.85	1.2726	1.6309	642.32
46750.	271.90	1.2339	1.5810	642.38
47000.	271.95	1.1964	1.5326	642.43
47250.	273.25	1.1604	1.4794	643.97
47500.	274.55	1.1254	1.4281	645.50
47750.	275.85	1.0916	1.3786	647.02
48000.	277.15	1.0587	1.3308	648.55
48250.	277.32	1.0272	1.2904	648.75
48500.	277.50	.9966	1.2511	648.96

TABLE I. - ARCASONDE DATA FROM CAPE KENNEDY, DEC. 16, 1965,

AT 1645 G. m. t. - Continued

Test no. 7402

Altitude, m	Temperature, °K	Pressure, mb	Density, gm/m^3	Velocity of sound knots
48750.	277.67	.9669	1.2131	649.16
49000.	277.85	.9381	1.1762	649.37
49250.	278.12	.9103	1.1402	649.69
49500.	278.40	.8832	1.1053	650.01
49750.	278.67	.8570	1.0714	650.33
50000.	278.95	.8316	1.0386	650.65
50250.	278.90	.8070	1.0080	650.59
50500.	278.85	.7831	.9783	650.53
50750.	278.80	.7599	.9495	650.47
51000.	278.75	.7374	.9216	650.42
51250.	278.47	.7155	.8951	650.10
51500.	278.20	.6942	.8694	649.77
51750.	277.92	.6736	.8444	649.45
52000.	277.65	.6536	.8202	649.13
52250.	276.37	.6340	.7992	647.64
52500.	275.10	.6150	.7788	646.14
52750.	273.82	.5965	.7590	644.65
53000.	272.55	.5787	.7397	643.14
53250.	272.90	.5612	.7164	643.56
53500.	273.25	.5442	.6939	643.97
53750.	273.60	.5278	.6721	644.38
54000.	273.95	.5119	.6510	644.79
54250.	273.00	.4964	.6334	643.67
54500.	272.05	.4813	.6164	642.55
54750.	271.10	.4667	.5998	641.43
55000.	270.15	.4526	.5836	640.30
55250.	269.60	.4387	.5669	639.65
55500.	269.05	.4253	.5507	639.00
55750.	268.50	.4122	.5349	638.35
56000.	267.95	.3996	.5196	637.69
56250.	268.25	.3873	.5031	638.05
56500.	268.55	.3755	.4871	638.41
56750.	268.85	.3639	.4716	638.76
57000.	269.15	.3528	.4566	639.12
57250.	268.80	.3419	.4432	638.70
57500.	268.45	.3314	.4301	638.29
57750.	268.10	.3213	.4175	637.87
58000.	267.75	.3114	.4052	637.45
58250.	266.37	.3017	.3946	635.82
58500.	265.00	.2924	.3844	634.17
58750.	263.62	.2833	.3744	632.52
59000.	262.25	.2745	.3646	630.87
59250.	261.90	.2658	.3536	630.45
59500.	261.55	.2575	.3430	630.03
59750.	261.20	.2494	.3326	629.61
60000.	260.85	.2415	.3226	629.19

TABLE I. - ARCASONDE DATA FROM CAPE KENNEDY, DEC. 16, 1965,

AT 1645 G. m. t. - Continued

Test no. 7402

Altitude, ft	Temperature, °K	Pressure mb	Density, gm/m^3	Velocity of sound, knots
78999.	213.25	29.0000	47.3764	568.89
79000.	213.25	28.9988	47.3744	568.89
80000.	214.07	27.6385	44.9776	569.99
81000.	214.90	26.3420	42.7026	571.09
82000.	215.73	25.1063	40.5434	572.19
83000.	215.98	23.9375	38.6101	572.53
84000.	216.23	22.8233	36.7715	572.85
85000.	216.47	21.7610	35.0204	573.18
86000.	217.20	20.7545	33.2878	574.15
87000.	218.15	19.7972	31.6149	575.39
88000.	219.09	18.8840	30.0266	576.64
89000.	219.80	18.0165	28.5556	577.56
90000.	220.16	17.1937	27.2062	578.04
91000.	220.53	16.4084	25.9206	578.52
92000.	220.91	15.6597	24.6950	579.03
93000.	221.40	14.9491	23.5225	579.66
94000.	221.89	14.2708	22.4058	580.30
95000.	222.37	13.6232	21.3422	580.94
96000.	222.58	13.0076	20.3594	581.20
97000.	222.73	12.4203	19.4268	581.40
98000.	222.88	11.8595	18.5370	581.60
99000.	223.14	11.3252	17.6814	581.94
100000.	223.47	10.8157	16.8607	582.37
101000.	223.81	10.3292	16.0782	582.81
102000.	224.37	9.8660	15.3189	583.54
103000.	225.47	9.4269	14.5658	584.96
104000.	226.56	9.0073	13.8501	586.38
105000.	227.67	8.6065	13.1694	587.81
106000.	229.44	8.2312	12.4981	590.09
107000.	231.20	7.8722	11.8617	592.36
108000.	232.97	7.5289	11.2583	594.62
109000.	234.27	7.2054	10.7148	596.28
110000.	235.40	6.8975	10.2077	597.71
111000.	236.53	6.6027	9.7249	599.14
112000.	237.83	6.3228	9.2615	600.79
113000.	239.36	6.0575	8.8164	602.71
114000.	240.88	5.8033	8.3930	604.63
115000.	242.37	5.5606	7.9926	606.49
116000.	243.68	5.3316	7.6223	608.13
117000.	244.99	5.1121	7.2694	609.77
118000.	246.30	4.9017	6.9331	611.39
119000.	247.56	4.7029	6.6182	612.95
120000.	248.81	4.5126	6.3184	614.50
121000.	250.06	4.3299	6.0324	616.04
122000.	253.00	4.1582	5.7258	619.65
123000.	257.02	3.9955	5.4157	624.56
124000.	261.04	3.8392	5.1236	629.42
125000.	263.62	3.6901	4.8763	632.53
126000.	263.26	3.5490	4.6964	632.09
127000.	262.89	3.4132	4.5231	631.65
128000.	262.56	3.2827	4.3556	631.26
129000.	262.96	3.1572	4.1828	631.73

TABLE I. - ARCASONDE DATA FROM CAPE KENNEDY, DEC. 16, 1965,

AT 1645 G. m. t. - Continued

Test no. 7402

Altitude, ft	Temperature, °K	Pressure mb	Density, gm/m^3	Velocity of sound, knots
130000.	263.36	3.0366	4.0168	632.21
131000.	263.75	2.9205	3.8575	632.68
132000.	263.80	2.8091	3.7097	632.74
133000.	263.74	2.7019	3.5690	632.67
134000.	263.68	2.5989	3.4337	632.59
135000.	263.48	2.4997	3.3051	632.36
136000.	263.15	2.4042	3.1828	631.96
137000.	262.81	2.3123	3.0651	631.55
138000.	262.61	2.2239	2.9502	631.32
139000.	262.95	2.1390	2.8339	631.72
140000.	263.28	2.0573	2.7222	632.12
141000.	263.62	1.9787	2.6148	632.52
142000.	264.21	1.9035	2.5099	633.23
143000.	264.82	1.8312	2.4090	633.96
144000.	265.43	1.7617	2.3122	634.69
145000.	266.43	1.6953	2.2167	635.89
146000.	267.65	1.6316	2.1238	637.34
147000.	268.87	1.5704	2.0348	638.79
148000.	269.88	1.5117	1.9514	639.99
149000.	270.52	1.4556	1.8745	640.75
150000.	271.16	1.4015	1.8007	641.50
151000.	271.75	1.3495	1.7301	642.20
152000.	271.81	1.2997	1.6658	642.28
153000.	271.87	1.2516	1.6039	642.35
154000.	271.93	1.2054	1.5442	642.42
155000.	273.21	1.1612	1.4807	643.93
156000.	274.80	1.1187	1.4183	645.80
157000.	276.38	1.0778	1.3586	647.66
158000.	277.26	1.0386	1.3050	648.68
159000.	277.47	1.0010	1.2568	648.93
160000.	277.68	.9648	1.2104	649.18
161000.	277.93	.9299	1.1656	649.46
162000.	278.26	.8964	1.1222	649.85
163000.	278.60	.8640	1.0804	650.24
164000.	278.93	.8329	1.0402	650.63
165000.	278.89	.8029	1.0029	650.58
166000.	278.83	.7740	.9671	650.51
167000.	278.76	.7461	.9324	650.44
168000.	278.52	.7192	.8996	650.15
169000.	278.18	.6933	.8682	649.76
170000.	277.85	.6683	.8379	649.37
171000.	277.03	.6441	.8100	648.41
172000.	275.47	.6206	.7848	646.59
173000.	273.92	.5980	.7605	644.76
174000.	272.59	.5762	.7363	643.20
175000.	273.02	.5550	.7082	643.70
176000.	273.45	.5347	.6812	644.21
177000.	273.87	.5150	.6551	644.71
178000.	272.98	.4961	.6331	643.65

TABLE I. - ARCASONDE DATA FROM CAPE KENNEDY, DEC. 16, 1965,

AT 1645 G. m. t. - Concluded

Test no. 7402

Altitude, ft	Temperature, °K	Pressure mb	Density gm/m^{-3}	Velocity sound, knots
179000.	271.82	.4778	.6124	642.29
180000.	270.66	.4602	.5923	640.92
181000.	269.77	.4432	.5723	639.86
182000.	269.10	.4267	.5523	639.07
183000.	268.43	.4108	.5331	638.27
184000.	268.04	.3955	.5140	637.81
185000.	268.41	.3807	.4942	638.25
186000.	268.78	.3665	.4751	638.68
187000.	269.14	.3529	.4568	639.12
188000.	268.72	.3397	.4404	638.62
189000.	268.29	.3270	.4247	638.11
190000.	267.87	.3148	.4095	637.60
191000.	266.55	.3030	.3960	636.03
192000.	264.88	.2916	.3835	634.03
193000.	263.20	.2806	.3714	632.02
194000.	262.06	.2699	.3588	630.65
195000.	261.63	.2596	.3457	630.14
196000.	261.21	.2497	.3330	629.62

TABLE II. - ARCASONDE DATA FROM GRAND TURK ISLAND, DEC. 16, 1965,

AT 1530 G. m. t.

Test no. 7219

Altitude, m	Temperature, °K	Pressure, mb	Density, gm/m^3	Velocity of sound, knots
24079.	216.35	29.1500	46.9391	573.01
24250.	216.77	28.3853	45.6177	573.58
24500.	217.40	27.3033	43.7528	574.40
24750.	218.02	26.2625	41.9645	575.22
25000.	218.65	25.2614	40.2497	576.05
25250.	219.45	24.3106	38.5934	577.10
25500.	220.25	23.3955	37.0059	578.15
25750.	221.05	22.5149	35.4841	579.20
26000.	221.85	21.6675	34.0253	580.25
26250.	221.17	20.8530	32.8464	579.36
26500.	220.50	20.0693	31.7085	578.48
26750.	219.82	19.3149	30.6104	577.59
27000.	219.15	18.5889	29.5506	576.71
27250.	219.82	17.8904	28.3529	577.59
27500.	220.50	17.2182	27.2040	578.48
27750.	221.17	16.5712	26.1019	579.36
28000.	221.85	15.9486	25.0447	580.25
28250.	221.95	15.3536	24.0995	580.38
28500.	222.05	14.7808	23.1900	580.51
28750.	222.15	14.2294	22.3148	580.64
29000.	222.25	13.6985	21.4727	580.77
29250.	223.12	13.1920	20.5976	581.91
29500.	224.00	12.7042	19.7585	583.05
29750.	224.87	12.2345	18.9538	584.19
30000.	225.75	11.7821	18.1822	585.33
30250.	227.07	11.3548	17.4206	587.04
30500.	228.40	10.9430	16.6914	588.75
30750.	229.72	10.5461	15.9933	590.46
31000.	231.05	10.1637	15.3249	592.16
31250.	231.87	9.8019	14.7268	593.21
31500.	232.70	9.4529	14.1522	594.27
31750.	233.52	9.1165	13.6002	595.32
32000.	234.35	8.7919	13.0699	596.37
32250.	234.45	8.4815	12.6031	596.50
32500.	234.55	8.1820	12.1529	596.63
32750.	234.65	7.8931	11.7187	596.75
33000.	234.75	7.6144	11.3001	596.88
33250.	234.72	7.3458	10.9027	596.85
33500.	234.70	7.0866	10.5192	596.82
33750.	234.67	6.8366	10.1492	596.78
34000.	234.65	6.5955	9.7922	596.75
34250.	236.45	6.3663	9.3799	599.04
34500.	238.25	6.1450	8.9856	601.31
34750.	240.05	5.9315	8.6083	603.58
35000.	241.85	5.7254	8.2473	605.84
35250.	244.82	5.5340	7.8748	609.55
35500.	247.80	5.3490	7.5202	613.25
35750.	250.77	5.1703	7.1826	616.92
36000.	253.75	4.9974	6.8611	620.56
36250.	254.62	4.8354	6.6159	621.63
36500.	255.50	4.6786	6.3795	622.70
36750.	256.37	4.5269	6.1515	623.77
37000.	257.25	4.3802	5.9319	624.83

TABLE II. - ARCASONDE DATA FROM GRAND TURK ISLAND, DEC. 16, 1965

AT 1530 G. m. t. - Continued

Test no. 7219

Altitude, m	Temperature, °K	Pressure, mb	Density, gm/m^3	Velocity of sound, knots
37250.	257.87	4.2398	5.7279	625.59
37500.	258.50	4.1040	5.5309	626.35
37750.	259.12	3.9725	5.3408	627.10
38000.	259.75	3.8452	5.1572	627.86
38250.	260.30	3.7231	4.9829	628.52
38500.	260.85	3.6049	4.8146	629.19
38750.	261.40	3.4904	4.6519	629.85
39000.	261.95	3.3796	4.4947	630.51
39250.	261.82	3.2727	4.3546	630.36
39500.	261.70	3.1692	4.2189	630.21
39750.	261.57	3.0689	4.0873	630.06
40000.	261.45	2.9718	3.9599	629.91
40250.	260.90	2.8773	3.8421	629.25
40500.	260.35	2.7859	3.7278	628.58
40750.	259.80	2.6973	3.6170	627.92
41000.	259.25	2.6116	3.5094	627.25
41250.	260.50	2.5290	3.3822	628.76
41500.	261.75	2.4490	3.2596	630.27
41750.	263.00	2.3716	3.1416	631.77
42000.	264.25	2.2967	3.0279	633.27
42250.	264.22	2.2247	2.9333	633.24
42500.	264.20	2.1551	2.8417	633.21
42750.	264.17	2.0876	2.7530	633.18
43000.	264.15	2.0222	2.6671	633.15
43250.	264.97	1.9593	2.5760	634.14
43500.	265.80	1.8983	2.4881	635.13
43750.	266.62	1.8392	2.4032	636.11
44000.	267.45	1.7820	2.3212	637.10
44250.	268.62	1.7274	2.2402	638.49
44500.	269.80	1.6744	2.1621	639.89
44750.	270.97	1.6231	2.0867	641.28
45000.	272.15	1.5733	2.0140	642.67
45250.	272.02	1.5255	1.9537	642.52
45500.	271.90	1.4791	1.8951	642.38
45750.	271.77	1.4341	1.8383	642.23
46000.	271.65	1.3905	1.7833	642.08
46250.	271.27	1.3481	1.7312	641.64
46500.	270.90	1.3069	1.6807	641.19
46750.	270.52	1.2670	1.6317	640.75
47000.	270.15	1.2284	1.5841	640.30
47250.	269.95	1.1907	1.5367	640.07
47500.	269.75	1.1543	1.4907	639.83
47750.	269.55	1.1189	1.4462	639.59
48000.	269.35	1.0846	1.4029	639.36
48250.	269.70	1.0515	1.3582	639.77
48500.	270.05	1.0193	1.3150	640.19
48750.	270.40	.9881	1.2731	640.60
49000.	270.75	.9579	1.2325	641.02
49250.	271.35	.9288	1.1925	641.73
49500.	271.95	.9006	1.1537	642.43
49750.	272.55	.8732	1.1162	643.14
50000.	273.15	.8467	1.0799	643.85

TABLE II. - ARCASONDE DATA FROM GRAND TURK ISLAND, DEC. 16, 1965,

AT 1530 G. m. t. - Continued

Test no. 7219

Altitude, ft	Temperature, °K	Pressure, mb	Density, gm/m^3	Velocity of sound, knots
78999.	216.35	29.1500	46.9391	573.01
79000.	216.35	29.1469	46.9371	573.01
80000.	217.11	27.7999	44.6080	574.02
81000.	217.87	26.5134	42.3950	575.02
82000.	218.63	25.2864	40.2923	576.03
83000.	219.60	24.1305	38.2805	577.30
84000.	220.58	23.0277	36.3696	578.59
85000.	221.55	21.9754	34.5547	579.86
86000.	221.27	20.9721	33.0189	579.50
87000.	220.45	20.0150	31.6297	578.42
88000.	219.62	19.1016	30.2994	577.34
89000.	219.49	18.2300	28.9347	577.16
90000.	220.31	17.3984	27.5115	578.24
91000.	221.13	16.6046	26.1587	579.32
92000.	221.86	15.8478	24.8847	580.27
93000.	221.98	15.1300	23.7444	580.43
94000.	222.11	14.4447	22.6565	580.59
95000.	222.23	13.7904	21.6183	580.75
96000.	223.16	13.1704	20.5604	581.96
97000.	224.22	12.5791	19.5439	583.35
98000.	225.29	12.0143	18.5780	584.74
99000.	226.67	11.4809	17.6448	586.53
100000.	228.29	10.9753	16.7484	588.62
101000.	229.90	10.4919	15.8984	590.69
102000.	231.34	10.0324	15.1076	592.54
103000.	232.35	9.5987	14.3920	593.82
104000.	233.35	9.1838	13.7105	595.11
105000.	234.35	8.7868	13.0622	596.37
106000.	234.47	8.4100	12.4956	596.53
107000.	234.59	8.0494	11.9535	596.68
108000.	234.71	7.7042	11.4350	596.84
109000.	234.72	7.3740	10.9445	596.85
110000.	234.69	7.0581	10.4770	596.81
111000.	234.66	6.7557	10.0294	596.77
112000.	235.64	6.4682	9.5629	598.01
113000.	237.83	6.1953	9.0748	600.79
114000.	240.03	5.9338	8.6123	603.56
115000.	242.46	5.6850	8.1682	606.61
116000.	246.09	5.4542	7.7211	611.13
117000.	249.72	5.2327	7.3000	615.62
118000.	253.35	5.0203	6.9034	620.08
119000.	254.69	4.8219	6.5954	621.72
120000.	255.76	4.6320	6.3092	623.03
121000.	256.83	4.4495	6.0355	624.32
122000.	257.71	4.2755	5.7797	625.39
123000.	258.47	4.1091	5.5383	626.32
124000.	259.23	3.9491	5.3071	627.24
125000.	259.97	3.7958	5.0867	628.12
126000.	260.64	3.6494	4.8779	628.93
127000.	261.31	3.5086	4.6777	629.74
128000.	261.94	3.3733	4.4865	630.50

TABLE II. - ARCASONDE DATA FROM GRAND TURK ISLAND, DEC. 16, 1965,

AT 1530 G. m. t. - Concluded

Test no. 7219

Altitude, ft	Temperature, °K	Pressure, mb	Density, gm/m³	Velocity of sound, knots
129000.	261.79	3.2437	4.3166	630.32
130000.	261.63	3.1190	4.1531	630.14
131000.	261.48	2.9991	3.9958	629.95
132000.	260.93	2.8834	3.8497	629.29
133000.	260.26	2.7720	3.7105	628.48
134000.	259.59	2.6650	3.5765	627.67
135000.	259.99	2.5623	3.4335	628.15
136000.	261.51	2.4639	3.2824	629.99
137000.	263.03	2.3693	3.1380	631.82
138000.	264.24	2.2785	3.0040	633.27
139000.	264.21	2.1918	2.8900	633.23
140000.	264.18	2.1084	2.7804	633.19
141000.	264.15	2.0282	2.6749	633.16
142000.	265.07	1.9514	2.5647	634.27
143000.	266.08	1.8777	2.4584	635.47
144000.	267.09	1.8067	2.3565	636.67
145000.	268.37	1.7390	2.2575	638.19
146000.	269.80	1.6742	2.1618	639.89
147000.	271.23	1.6119	2.0703	641.59
148000.	272.09	1.5520	1.9871	642.61
149000.	271.94	1.4946	1.9148	642.43
150000.	271.78	1.4394	1.8450	642.25
151000.	271.61	1.3862	1.7780	642.04
152000.	271.15	1.3348	1.7150	641.49
153000.	270.69	1.2853	1.6542	640.95
154000.	270.24	1.2377	1.5955	640.41
155000.	269.95	1.1916	1.5378	640.07
156000.	269.71	1.1473	1.4819	639.78
157000.	269.46	1.1046	1.4280	639.49
158000.	269.57	1.0635	1.3744	639.62
159000.	269.99	1.0239	1.3212	640.13
160000.	270.42	.9859	1.2701	640.63
161000.	270.92	.9493	1.2207	641.22
162000.	271.65	.9143	1.1725	642.09
163000.	272.38	.8805	1.1262	642.95
164000.	273.11	.8480	1.0817	643.81

TABLE III. - ARCASONDE DATA FROM CAPE KENNEDY, DEC. 18, 1965,

AT 1510 G. m. t.

Test no. 7428

Altitude, m	Temperature, °K	Pressure, mb	Density, gm/m^3	Velocity of sound, knots
24078.	213.35	28.8300	47.0766	569.02
24250.	213.46	28.0558	45.7884	569.17
24500.	213.62	26.9675	43.9787	569.39
24750.	213.78	25.9213	42.2405	569.61
25000.	213.95	24.9158	40.5711	569.82
25250.	216.55	23.9734	38.5677	573.27
25500.	219.15	23.0666	36.6686	576.71
25750.	221.75	22.1940	34.8680	580.12
26000.	224.35	21.3545	33.1603	583.51
26250.	224.27	20.5649	31.9447	583.41
26500.	224.20	19.8044	30.7738	583.31
26750.	224.12	19.0721	29.6457	583.22
27000.	224.05	18.3669	28.5590	583.12
27250.	223.35	17.6833	27.5823	582.21
27500.	222.65	17.0251	26.6392	581.29
27750.	221.95	16.3914	25.7286	580.38
28000.	221.25	15.7814	24.8493	579.46
28250.	221.72	15.1930	23.8717	580.08
28500.	222.20	14.6266	22.9326	580.71
28750.	222.67	14.0813	22.0305	581.33
29000.	223.15	13.5563	21.1640	581.95
29250.	224.07	13.0572	20.3007	583.15
29500.	225.00	12.5765	19.4730	584.35
29750.	225.92	12.1135	18.6793	585.55
30000.	226.85	11.6676	17.9182	586.75
30250.	228.10	11.2461	17.1764	588.36
30500.	229.35	10.8400	16.4658	589.97
30750.	230.60	10.4484	15.7850	591.58
31000.	231.85	10.0710	15.1329	593.18
31250.	232.65	9.7137	14.5457	594.20
31500.	233.45	9.3690	13.9815	595.22
31750.	234.25	9.0365	13.4393	596.24
32000.	235.05	8.7159	12.9183	597.26
32250.	235.90	8.4109	12.4214	598.34
32500.	236.75	8.1166	11.9437	599.42
32750.	237.60	7.8327	11.4846	600.49
33000.	238.45	7.5586	11.0433	601.56
33250.	239.42	7.2982	10.6194	602.79
33500.	240.40	7.0467	10.2119	604.02
33750.	241.37	6.8039	9.8202	605.24
34000.	242.35	6.5695	9.4437	606.46
34250.	242.87	6.3459	9.1026	607.12
34500.	243.40	6.1300	8.7739	607.78
34750.	243.92	5.9214	8.4571	608.43
35000.	244.45	5.7199	8.1518	609.09
35250.	244.62	5.5264	7.8704	609.30
35500.	244.80	5.3395	7.5988	609.52
35750.	244.97	5.1589	7.3365	609.74
36000.	245.15	4.9844	7.0833	609.96

TABLE III. - ARCASONDE DATA FROM CAPE KENNEDY, DEC. 18, 1965,

AT 1510 G. m. t. - Continued

Test no. 7428

Altitude, m	Temperature, °K	Pressure, mb	Density, gm/m³	Velocity of sound, knots
36250.	247.55	4.8192	6.7822	612.94
36500.	249.95	4.6596	6.4945	615.90
36750.	252.35	4.5052	6.2196	618.85
37000.	254.75	4.3559	5.9569	621.79
37250.	254.72	4.2143	5.7638	621.76
37500.	254.70	4.0773	5.5770	621.73
37750.	254.67	3.9447	5.3962	621.69
38000.	254.65	3.8165	5.2212	621.66
38250.	255.52	3.6932	5.0353	622.73
38500.	256.40	3.5740	4.8561	623.80
38750.	257.27	3.4586	4.6833	624.86
39000.	253.15	3.3469	4.5167	625.92
39250.	257.92	3.2394	4.3755	625.65
39500.	257.70	3.1353	4.2386	625.38
39750.	257.47	3.0346	4.1061	625.10
40000.	257.25	2.9372	3.9776	624.83
40250.	256.85	2.8424	3.8553	624.34
40500.	256.45	2.7507	3.7367	623.86
40750.	256.05	2.6619	3.6218	623.37
41000.	255.65	2.5760	3.5104	622.88
41250.	254.20	2.4918	3.4150	621.11
41500.	252.75	2.4102	3.3222	619.34
41750.	251.30	2.3314	3.2320	617.56
42000.	249.85	2.2551	3.1444	615.78
42250.	250.30	2.1807	3.0353	616.33
42500.	250.75	2.1088	2.9300	616.89
42750.	251.20	2.0393	2.8283	617.44
43000.	251.65	1.9721	2.7302	617.99
43250.	251.67	1.9073	2.6403	618.02
43500.	251.70	1.8447	2.5533	618.05
43750.	251.72	1.7842	2.4692	618.08
44000.	251.75	1.7256	2.3879	618.11
44250.	253.67	1.6698	2.2932	620.47
44500.	255.60	1.6158	2.2023	622.82
44750.	257.52	1.5636	2.1152	625.16
45000.	259.45	1.5130	2.0316	627.50
45250.	260.92	1.4654	1.9565	629.28
45500.	262.40	1.4192	1.8842	631.05
45750.	263.87	1.3745	1.8147	632.82
46000.	265.35	1.3312	1.7478	634.59
46250.	266.82	1.2902	1.6846	636.35
46500.	268.30	1.2504	1.6237	638.11
46750.	269.77	1.2119	1.5651	639.86
47000.	271.25	1.1746	1.5086	641.61
47250.	273.40	1.1394	1.4518	644.14
47500.	275.55	1.1052	1.3973	646.67
47750.	277.70	1.0720	1.3449	649.19
48000.	279.85	1.0399	1.2945	651.70
48250.	280.50	1.0093	1.2535	652.46
48500.	281.15	.9796	1.2139	653.21

TABLE III. - ARCASONDE DATA FROM CAPE KENNEDY, DEC. 18, 1965,

AT 1510 G. m. t. - Continued

Test no. 7428

Altitude, m	Temperature, °K	Pressure, mb	Density, gm/m^3	Velocity of sound, knots
48750.	281.80	.9508	1.1755	653.97
49000.	282.45	.9229	1.1383	654.72
49250.	281.87	.8958	1.1071	654.05
49500.	281.30	.8694	1.0768	653.38
49750.	280.72	.8439	1.0473	652.72
50000.	280.15	.8191	1.0186	652.05
50250.	279.45	.7948	.9909	651.23
50500.	278.75	.7713	.9640	650.42
50750.	278.05	.7484	.9377	649.60
51000.	277.35	.7262	.9123	648.78
51250.	276.70	.7045	.8870	648.02
51500.	276.05	.6835	.8625	647.26
51750.	275.40	.6630	.8387	646.50
52000.	274.75	.6432	.8156	645.73
52250.	274.67	.6239	.7913	645.64
52500.	274.60	.6051	.7677	645.56
52750.	274.52	.5869	.7448	645.47
53000.	274.45	.5693	.7226	645.38
53250.	274.45	.5522	.7009	645.38
53500.	274.45	.5356	.6798	645.38
53750.	274.45	.5195	.6594	645.38
54000.	274.45	.5038	.6396	645.38
54250.	273.65	.4886	.6221	644.44
54500.	272.85	.4738	.6050	643.50
54750.	272.05	.4595	.5885	642.55
55000.	271.25	.4456	.5724	641.61

TABLE III. - ARCASONDE DATA FROM CAPE KENNEDY, DEC. 18, 1965,

AT 1510 G. m. t. - Concluded

Test no. 7428

Altitude, ft	Temperature, °K	Pressure, mb	Density, gm/m³	Velocity of sound, knots
129000.	257.86	3.2102	4.3371	625.57
130000.	257.58	3.0849	4.1723	625.24
131000.	257.31	2.9646	4.0138	624.91
132000.	256.87	2.8485	3.8632	624.38
133000.	256.38	2.7368	3.7188	623.78
134000.	255.90	2.6296	3.5799	623.19
135000.	254.79	2.5258	3.4536	621.84
136000.	253.02	2.4254	3.3395	619.68
137000.	251.25	2.3290	3.2293	617.51
138000.	249.96	2.2363	3.1168	615.92
139000.	250.51	2.1467	2.9854	616.59
140000.	251.05	2.0607	2.8596	617.27
141000.	251.60	1.9782	2.7391	617.94
142000.	251.67	1.8993	2.6291	618.03
143000.	251.70	1.8235	2.5239	618.06
144000.	251.73	1.7508	2.4229	618.10
145000.	253.25	1.6817	2.3133	619.96
146000.	255.60	1.6156	2.2020	622.83
147000.	257.95	1.5522	2.0963	625.68
148000.	260.10	1.4918	1.9981	628.28
149000.	261.90	1.4347	1.9084	630.45
150000.	263.69	1.3798	1.8229	632.61
151000.	265.49	1.3271	1.7414	634.77
152000.	267.29	1.2774	1.6649	636.91
153000.	269.09	1.2296	1.5919	639.05
154000.	270.89	1.1836	1.5221	641.18
155000.	273.34	1.1402	1.4532	644.08
156000.	275.97	1.0986	1.3869	647.17
157000.	278.59	1.0586	1.3238	650.23
158000.	280.26	1.0204	1.2684	652.18
159000.	281.05	.9839	1.2196	653.10
160000.	281.84	.9488	1.1727	654.02
161000.	282.28	.9149	1.1291	654.52
162000.	281.58	.8822	1.0915	653.71
163000.	280.88	.8507	1.0552	652.90
164000.	280.17	.8203	1.0200	652.08
165000.	279.33	.7908	.9863	651.10
166000.	278.47	.7623	.9537	650.10
167000.	277.62	.7349	.9222	649.10
168000.	276.81	.7083	.8914	648.15
169000.	276.02	.6825	.8615	647.22
170000.	275.22	.6577	.8325	646.29
171000.	274.71	.6338	.8037	645.69
172000.	274.62	.6106	.7746	645.58
173000.	274.53	.5883	.7466	645.48
174000.	274.45	.5668	.7195	645.38
175000.	274.45	.5461	.6932	645.38
176000.	274.45	.5262	.6679	645.38
177000.	274.45	.5069	.6435	645.38
178000.	273.63	.4883	.6218	644.42
179000.	272.66	.4704	.6011	643.27
180000.	271.68	.4531	.5811	642.12

TABLE III. - ARCASONDE DATA FROM CAPE KENNEDY, DEC. 18, 1965,

AT 1510 G. m. t. - Continued

Test no. 7428

Altitude, ft	Temperature, °K	Pressure, mb	Density, gm/m³	Velocity of sound, knots
78995.	213.35	28.8300	47.0766	569.02
79000.	213.35	28.8243	47.0671	569.02
80000.	213.54	27.4669	44.8090	569.29
81000.	213.74	26.1734	42.6592	569.55
82000.	213.94	24.9409	40.6126	569.82
83000.	217.05	23.7949	38.1917	573.94
84000.	220.22	22.7021	35.9133	578.12
85000.	223.39	21.6596	33.7779	582.26
86000.	224.28	20.6804	32.1225	583.42
87000.	224.19	19.7518	30.6927	583.31
88000.	224.10	18.8650	29.3266	583.19
89000.	223.69	18.0157	28.0576	582.65
90000.	222.84	17.2015	26.8922	581.54
91000.	221.98	16.4242	25.7757	580.43
92000.	221.32	15.6818	24.6837	579.57
93000.	221.90	14.9719	23.5049	580.32
94000.	222.48	14.2942	22.3825	581.08
95000.	223.06	13.6471	21.3138	581.84
96000.	224.11	13.0360	20.2540	583.20
97000.	225.24	12.4532	19.2613	584.67
98000.	226.37	11.8966	18.3086	586.13
99000.	227.72	11.3705	17.3949	587.88
100000.	229.25	10.8718	16.5214	589.85
101000.	230.77	10.3950	15.6924	591.80
102000.	232.13	9.9414	14.9196	593.55
103000.	233.11	9.5130	14.2169	594.79
104000.	234.08	9.1030	13.5476	596.04
105000.	235.06	8.7108	12.9101	597.28
106000.	236.10	8.3407	12.3072	598.59
107000.	237.13	7.9863	11.7328	599.91
108000.	238.17	7.6469	11.1853	601.22
109000.	239.32	7.3256	10.6639	602.66
110000.	240.50	7.0190	10.1671	604.16
111000.	241.69	6.7253	9.6938	605.65
112000.	242.63	6.4454	9.2543	606.83
113000.	243.27	6.1790	8.8485	607.63
114000.	243.91	5.9236	8.4605	608.42
115000.	244.48	5.6791	8.0924	609.13
116000.	244.69	5.4457	7.7531	609.40
117000.	244.91	5.2220	7.4281	609.66
118000.	245.12	5.0074	7.1167	609.93
119000.	247.75	4.8054	6.7572	613.19
120000.	250.68	4.6121	6.4096	616.80
121000.	253.60	4.4264	6.0806	620.39
122000.	254.73	4.2503	5.8129	621.76
123000.	254.70	4.0824	5.5840	621.73
124000.	254.67	3.9212	5.3641	621.69
125000.	255.00	3.7667	5.1460	622.09
126000.	256.06	3.6189	4.9235	623.39
127000.	257.13	3.4769	4.7108	624.69
128000.	258.13	3.3406	4.5084	625.91

TABLE IV. - ARCASONDE DATA FROM GRAND TURK ISLAND, DEC. 18, 1965,

AT 1500 G. m. t.

Test no. 7323

Altitude, m	Temperature, °K	Pressure, mb	Density, gm/m³	Velocity of sound, knots
24078.	213.85	29.0000	46.1641	576.31
24250.	218.08	28.2324	45.0998	575.30
24500.	216.97	27.1528	43.5975	573.83
24750.	215.86	26.1145	42.1463	572.36
25000.	214.75	25.1159	40.7445	570.89
25250.	215.52	24.1536	39.0425	571.92
25500.	216.30	23.2252	37.4121	572.94
25750.	217.07	22.3332	35.8503	573.97
26000.	217.85	21.4823	34.3540	574.99
26250.	217.85	20.6653	33.0474	574.99
26500.	217.85	19.8793	31.7904	574.99
26750.	217.85	19.1231	30.5813	574.99
27000.	217.85	18.3958	29.4181	574.99
27250.	218.80	17.7023	28.1861	576.25
27500.	219.75	17.0349	27.0062	577.49
27750.	220.70	16.3926	25.8762	578.74
28000.	221.65	15.7746	24.7939	579.99
28250.	222.40	15.1890	23.7929	580.97
28500.	223.15	14.6251	22.8325	581.95
28750.	223.90	14.0821	21.9112	582.92
29000.	224.65	13.5593	21.0273	583.90
29250.	225.10	13.0613	20.2146	584.48
29500.	225.55	12.5816	19.4333	585.07
29750.	226.00	12.1195	18.6823	585.65
30000.	226.45	11.6744	17.9604	586.23
30250.	227.62	11.2517	17.2208	587.75
30500.	228.80	10.8444	16.5121	589.27
30750.	229.97	10.4518	15.8330	590.78
31000.	231.15	10.0734	15.1822	592.29
31250.	231.50	9.7135	14.6177	592.73
31500.	231.85	9.3665	14.0742	593.18
31750.	232.20	9.0319	13.5509	593.63
32000.	232.55	8.7092	13.0472	594.08
32250.	234.45	8.4040	12.4879	596.50
32500.	236.35	8.1094	11.9534	598.91
32750.	238.25	7.8252	11.4424	601.31
33000.	240.15	7.5510	10.9541	603.71
33250.	242.17	7.2948	10.4939	606.25
33500.	244.20	7.0473	10.0538	608.77
33750.	246.22	6.8082	9.6328	611.29
34000.	248.25	6.5772	9.2301	613.80
34250.	248.05	6.3573	8.9288	613.56
34500.	247.85	6.1448	8.6373	613.31
34750.	247.65	5.9394	8.3553	613.06
35000.	247.45	5.7409	8.0825	612.81
35250.	247.65	5.5491	7.8061	613.06
35500.	247.85	5.3636	7.5392	613.31
35750.	248.05	5.1844	7.2814	613.56
36000.	248.25	5.0111	7.0324	613.80

TABLE IV. - ARCASONDE DATA FROM GRAND TURK ISLAND, DEC. 18, 1965,

AT 1500 G. m. t. - Continued

Test no. 7323

Altitude, m	Temperature, °K	Pressure, mb	Density, gm/m^3	Velocity of sound, knots
36250.	243.57	4.8444	6.7895	614.20
36500.	243.90	4.6833	6.5551	614.61
36750.	249.22	4.5275	6.3288	615.01
37000.	249.55	4.3768	6.1102	615.41
37250.	250.45	4.2327	5.8877	616.52
37500.	251.35	4.0933	5.6734	617.62
37750.	252.25	3.9534	5.4670	618.73
38000.	253.15	3.8280	5.2681	619.83
38250.	255.40	3.7050	5.0539	622.58
38500.	257.65	3.5860	4.8487	625.32
38750.	259.90	3.4707	4.6523	628.04
39000.	262.15	3.3592	4.4641	630.75
39250.	261.55	3.2526	4.3324	630.03
39500.	260.95	3.1494	4.2046	629.31
39750.	260.35	3.0495	4.0806	628.58
40000.	259.75	2.9527	3.9603	627.86
40250.	258.55	2.8578	3.8507	626.41
40500.	257.35	2.7659	3.7443	624.95
40750.	256.15	2.6770	3.6409	623.49
41000.	254.95	2.5909	3.5404	622.03
41250.	255.60	2.5073	3.4174	622.82
41500.	256.25	2.4263	3.2987	623.61
41750.	256.90	2.3480	3.1841	624.40
42000.	257.55	2.2722	3.0736	625.19
42250.	257.55	2.1992	2.9749	625.19
42500.	257.55	2.1286	2.8793	625.19
42750.	257.55	2.0603	2.7869	625.19
43000.	257.55	1.9941	2.6974	625.19
43250.	257.52	1.9301	2.6111	625.16
43500.	257.50	1.8681	2.5275	625.13
43750.	257.47	1.8082	2.4466	625.10
44000.	257.45	1.7501	2.3682	625.07
44250.	260.17	1.6951	2.2697	628.37
44500.	262.90	1.6418	2.1756	631.65
44750.	265.62	1.5901	2.0855	634.92
45000.	268.35	1.5401	1.9994	638.17
45250.	269.22	1.4930	1.9319	639.21
45500.	270.10	1.4473	1.8667	640.25
45750.	270.97	1.4030	1.8037	641.28
46000.	271.85	1.3600	1.7429	642.32
46250.	272.37	1.3188	1.6868	642.94
46500.	272.90	1.2789	1.6326	643.56
46750.	273.42	1.2401	1.5801	644.17
47000.	273.95	1.2026	1.5293	644.79
47250.	273.95	1.1663	1.4831	644.79
47500.	273.95	1.1311	1.4384	644.79
47750.	273.95	1.0970	1.3950	644.79
48000.	273.95	1.0639	1.3529	644.79
48250.	273.65	1.0317	1.3135	644.44
48500.	273.35	1.0005	1.2752	644.09
48750.	273.05	.9703	1.2380	643.73
49000.	272.75	.9409	1.2019	643.38

TABLE IV. - ARCASONDE DATA FROM GRAND TURK ISLAND, DEC. 18, 1965

AT 1500 G. m. t. - Continued

Test no. 7323

Altitude, m	Temperature, °K	Pressure, mb	Density, gm/m³	Velocity of sound, knots
49250.	273.10	.9125	1.1641	643.79
49500.	273.45	.8850	1.1275	644.20
49750.	273.80	.8582	1.0920	644.62
50000.	274.15	.8323	1.0577	645.03
50250.	274.32	.8073	1.0252	645.23
50500.	274.50	.7830	.9937	645.44
50750.	274.67	.7594	.9632	645.64
51000.	274.85	.7366	.9336	645.85
51250.	275.55	.7146	.9034	646.67
51500.	276.25	.6932	.8742	647.49
51750.	276.95	.6725	.8459	648.31
52000.	277.65	.6524	.8186	649.13
52250.	277.15	.6329	.7956	648.55
52500.	276.65	.6140	.7733	647.96
52750.	276.15	.5957	.7515	647.38
53000.	275.65	.5779	.7304	646.79
53250.	275.07	.5606	.7100	646.11
53500.	274.50	.5437	.6901	645.44
53750.	273.92	.5274	.6707	644.76
54000.	273.35	.5115	.6519	644.09

TABLE IV. - ARCASONDE DATA FROM GRAND TURK ISLAND, DEC. 18, 1965,

AT 1500 G. m. t. - Continued

Test no. 7323

Altitude, ft	Temperature, °K	Pressure, mb	Density, gm/m^3	Velocity of sound, knots
78995.	212.65	29.0000	46.1641	576.31
79000.	213.84	28.9943	46.1563	576.30
80000.	217.48	27.6493	44.2878	574.52
81000.	216.13	26.3648	42.4967	572.72
82000.	214.77	25.1408	40.7796	570.92
83000.	215.67	23.9714	38.7211	572.12
84000.	216.62	22.8564	36.7589	573.37
85000.	217.56	21.7933	34.8969	574.62
86000.	217.85	20.7847	33.2383	574.99
87000.	217.85	19.8249	31.7035	574.99
88000.	217.85	18.9094	30.2395	574.99
89000.	218.33	18.0394	28.7843	575.63
90000.	219.49	17.2137	27.3218	577.16
91000.	220.65	16.4258	25.9344	578.68
92000.	221.77	15.6755	24.6242	580.15
93000.	222.68	14.9689	23.4176	581.34
94000.	223.60	14.2941	22.2706	582.54
95000.	224.51	13.6497	21.1800	583.73
96000.	225.11	13.0401	20.1800	584.51
97000.	225.66	12.4585	19.2332	585.22
98000.	226.21	11.9029	18.3309	585.93
99000.	227.27	11.3765	17.4386	587.30
100000.	228.70	10.8763	16.5675	589.15
101000.	230.13	10.3982	15.7406	590.99
102000.	231.27	9.9428	14.9773	592.45
103000.	231.70	9.5114	14.3011	592.99
104000.	232.12	9.0988	13.6555	593.54
105000.	232.58	8.7042	13.0379	594.12
106000.	234.89	8.3337	12.3598	597.07
107000.	237.21	7.9790	11.7182	600.00
108000.	239.53	7.6394	11.1109	602.93
109000.	241.95	7.3218	10.5422	605.97
110000.	244.42	7.0200	10.0056	609.06
111000.	246.89	6.7307	9.4974	612.13
112000.	248.13	6.4552	9.0629	613.67
113000.	247.89	6.1931	8.7035	613.36
114000.	247.65	5.9416	8.3583	613.06
115000.	247.49	5.7004	8.0242	612.86
116000.	247.73	5.4690	7.6909	613.17
117000.	247.97	5.2470	7.3714	613.47
118000.	248.22	5.0340	7.0653	613.77
119000.	248.60	4.8305	6.7693	614.24
120000.	248.99	4.6353	6.4854	614.73
121000.	249.39	4.4480	6.2134	615.22
122000.	250.21	4.2693	5.9442	616.23
123000.	251.31	4.0985	5.6814	617.58
124000.	252.41	3.9345	5.4304	618.93
125000.	254.05	3.7783	5.1812	620.93
126000.	256.79	3.6308	4.9258	624.28
127000.	259.53	3.4890	4.6834	627.60

TABLE IV. - ARCASONDE DATA FROM GRAND TURK ISLAND, DEC. 18, 1965,

AT 1500 G. m. t. - Concluded

Test no. 7323

Altitude, ft	Temperature, °K	Pressure, mb	Density, gm/m^3	Velocity of sound, knots
128000.	262.11	3.3529	4.4564	630.71
129000.	261.38	3.2237	4.2966	629.83
130000.	260.65	3.0994	4.1426	628.95
131000.	259.92	2.9799	3.9941	628.06
132000.	258.62	2.8639	3.8578	626.50
133000.	257.16	2.7520	3.7282	624.73
134000.	255.70	2.6445	3.6030	622.95
135000.	255.33	2.5410	3.4670	622.50
136000.	256.12	2.4414	3.3207	623.47
137000.	256.91	2.3456	3.1807	624.43
138000.	257.55	2.2537	3.0486	625.19
139000.	257.55	2.1658	2.9297	625.19
140000.	257.55	2.0813	2.8154	625.19
141000.	257.55	2.0001	2.7056	625.19
142000.	257.52	1.9221	2.6003	625.16
143000.	257.49	1.8472	2.4992	625.12
144000.	257.46	1.7751	2.4020	625.09
145000.	259.58	1.7068	2.2906	627.66
146000.	262.90	1.6416	2.1753	631.67
147000.	266.23	1.5788	2.0660	635.64
148000.	268.73	1.5191	1.9693	638.63
149000.	269.80	1.4626	1.8886	639.89
150000.	270.87	1.4082	1.8112	641.16
151000.	271.90	1.3559	1.7372	642.38
152000.	272.54	1.3059	1.6694	643.13
153000.	273.18	1.2579	1.6041	643.89
154000.	273.82	1.2116	1.5415	644.64
155000.	273.95	1.1671	1.4842	644.79
156000.	273.95	1.1243	1.4298	644.79
157000.	273.95	1.0831	1.3774	644.79
158000.	273.75	1.0434	1.3278	644.57
159000.	273.39	1.0050	1.2807	644.14
160000.	273.02	.9681	1.2353	643.71
161000.	272.85	.9326	1.1907	643.50
162000.	273.27	.8983	1.1452	644.00
163000.	273.70	.8654	1.1015	644.50
164000.	274.13	.8336	1.0594	645.01
165000.	274.35	.8031	1.0198	645.27
166000.	274.56	.7738	.9818	645.52
167000.	274.78	.7455	.9452	645.77
168000.	275.42	.7183	.9086	646.53
169000.	276.28	.6923	.8729	647.53
170000.	277.13	.6671	.8386	648.53
171000.	277.40	.6429	.8074	648.85
172000.	276.79	.6196	.7798	648.14
173000.	276.18	.5971	.7532	647.42
174000.	275.56	.5755	.7275	646.69
175000.	274.86	.5544	.7027	645.87
176000.	274.16	.5342	.6788	645.05
177000.	273.46	.5147	.6557	644.22

TABLE V. - ARCASONDE DATA FROM GRAND TURK ISLAND, DEC. 18, 1965,

AT 1410 G. m. t.

Test no. 7427

Altitude, m	Temperature, °K	Pressure, mb	Density, gm/m^3	Velocity of sound, knots
24078.	218.85	29.0000	46.1641	576.31
24250.	218.83	28.2393	44.9571	576.29
24500.	218.80	27.1691	43.2587	576.25
24750.	218.77	26.1395	41.6246	576.22
25000.	218.75	25.1490	40.0521	576.18
25250.	218.60	24.1947	38.5588	575.98
25500.	218.45	23.2766	37.1212	575.78
25750.	218.30	22.3934	35.7372	575.59
26000.	218.15	21.5437	34.4048	575.39
26250.	218.02	20.7245	33.1155	575.22
26500.	217.90	19.9364	31.8745	575.06
26750.	217.77	19.1783	30.6800	574.89
27000.	217.65	18.4490	29.5303	574.73
27250.	218.82	17.7542	28.2656	576.28
27500.	220.00	17.0856	27.0559	577.82
27750.	221.17	16.4422	25.8987	579.36
28000.	222.35	15.8230	24.7916	580.90
28250.	223.37	15.2388	23.7667	582.24
28500.	224.40	14.6761	22.7846	583.57
28750.	225.42	14.1342	21.8436	584.90
29000.	226.45	13.6123	20.9418	586.23
29250.	226.92	13.1164	20.1366	586.85
29500.	227.40	12.6385	19.3624	587.46
29750.	227.87	12.1780	18.6181	588.07
30000.	228.35	11.7343	17.9024	588.69
30250.	228.95	11.3109	17.2111	589.46
30500.	229.55	10.9027	16.5467	590.23
30750.	230.15	10.5092	15.9080	591.00
31000.	230.75	10.1300	15.2940	591.77
31250.	231.30	9.7681	14.7126	592.48
31500.	231.85	9.4191	14.1533	593.18
31750.	232.40	9.0826	13.6154	593.88
32000.	232.95	8.7582	13.0980	594.59
32250.	234.25	8.4502	12.5673	596.24
32500.	235.55	8.1531	12.0584	597.90
32750.	236.85	7.8664	11.5706	599.54
33000.	238.15	7.5898	11.1028	601.19
33250.	240.80	7.3315	10.6069	604.52
33500.	243.45	7.0820	10.1344	607.84
33750.	246.10	6.8410	9.6841	611.14
34000.	248.75	6.6082	9.2549	614.42
34250.	247.95	6.3867	8.9735	613.43
34500.	247.15	6.1726	8.7008	612.44
34750.	246.35	5.9657	8.4365	611.45
35000.	245.55	5.7657	8.1802	610.46
35250.	246.15	5.5722	7.8864	611.20
35500.	246.75	5.3852	7.6032	611.95
35750.	247.35	5.2044	7.3302	612.69
36000.	247.95	5.0297	7.0670	613.43

TABLE V. - ARCASONDE DATA FROM GRAND TURK ISLAND, DEC. 18, 1965,

AT 1410 G. m. t. - Continued

Test no 7427

Altitude, m	Temperature, °K	Pressure, mb	Density, gm/m^3	Velocity of sound, knots
36250.	248.15	4.8620	6.8259	613.68
36500.	248.35	4.6999	6.5930	613.93
36750.	248.55	4.5432	6.3681	614.17
37000.	248.75	4.3918	6.1508	614.42
37250.	249.42	4.2464	5.9311	615.25
37500.	250.10	4.1058	5.7193	616.09
37750.	250.77	3.9699	5.5151	616.92
38000.	251.45	3.8365	5.3182	617.75
38250.	254.25	3.7149	5.0902	621.18
38500.	257.05	3.5952	4.8726	624.59
38750.	259.85	3.4794	4.6649	627.98
39000.	262.65	3.3673	4.4665	631.35
39250.	262.15	3.2608	4.3334	630.75
39500.	261.65	3.1576	4.2043	630.15
39750.	261.15	3.0577	4.0790	629.55
40000.	260.65	2.9609	3.9575	628.95
40250.	260.22	2.8666	3.8377	628.43
40500.	259.80	2.7753	3.7216	627.92
40750.	259.37	2.6869	3.6089	627.41
41000.	258.95	2.6013	3.4997	626.89
41250.	259.30	2.5184	3.3836	627.31
41500.	259.65	2.4382	3.2714	627.74
41750.	260.00	2.3605	3.1629	628.16
42000.	260.35	2.2853	3.0580	628.58
42250.	259.80	2.2123	2.9667	627.92
42500.	259.25	2.1418	2.8781	627.25
42750.	258.70	2.0734	2.7922	626.59
43000.	258.15	2.0073	2.7089	625.92
43250.	257.60	1.9427	2.6274	625.25
43500.	257.05	1.8803	2.5483	624.59
43750.	256.50	1.8198	2.4717	623.92
44000.	255.95	1.7613	2.3973	623.25
44250.	258.15	1.7053	2.3014	625.92
44500.	260.35	1.6512	2.2095	628.58
44750.	262.55	1.5988	2.1214	631.23
45000.	264.75	1.5480	2.0370	633.87

TABLE V. - ARCASONDE DATA FROM GRAND TURK ISLAND, DEC. 18, 1965,

AT 1410 G. m. t. - Continued

Test no. 7427

Altitude, ft	Temperature, °K	Pressure, mb	Density, gm/m^3	Velocity of sound, knots
78995.	218.85	29.0000	46.1641	576.31
79000.	218.84	28.9944	46.1552	576.31
80000.	218.81	27.6604	44.0383	576.27
81000.	218.78	26.3877	42.0185	576.22
82000.	218.75	25.1736	40.0913	576.18
83000.	218.57	24.0140	38.2759	575.94
84000.	218.38	22.9077	36.5432	575.70
85000.	218.20	21.8524	34.8890	575.46
86000.	218.04	20.8442	33.3040	575.25
87000.	217.89	19.8819	31.7886	575.05
88000.	217.73	18.9640	30.3423	574.85
89000.	218.24	18.0920	28.8795	575.52
90000.	219.68	17.2648	27.3794	577.40
91000.	221.11	16.4754	25.9582	579.28
92000.	222.52	15.7241	24.6178	581.12
93000.	223.77	15.0192	23.3828	582.75
94000.	225.02	14.3458	22.2105	584.38
95000.	226.26	13.7026	21.0975	586.00
96000.	226.94	13.0953	20.1023	586.87
97000.	227.52	12.5159	19.1641	587.62
98000.	228.10	11.9622	18.2697	588.37
99000.	228.77	11.4359	17.4150	589.23
100000.	229.50	10.9347	16.5987	590.17
101000.	230.23	10.4555	15.8209	591.11
102000.	230.94	9.9987	15.0829	592.03
103000.	231.61	9.5649	14.3867	592.88
104000.	232.28	9.1499	13.7229	593.74
105000.	232.97	8.7531	13.0892	594.61
106000.	234.55	8.3793	12.4455	596.63
107000.	236.14	8.0214	11.8341	598.65
108000.	237.72	7.6789	11.2532	600.65
109000.	240.51	7.3587	10.6588	604.17
110000.	243.74	7.0545	10.0828	608.21
111000.	246.97	6.7629	9.5396	612.23
112000.	248.30	6.4852	9.0989	613.88
113000.	247.33	6.2212	8.7628	612.67
114000.	246.35	5.9679	8.4393	611.46
115000.	245.67	5.7248	8.1182	610.61
116000.	246.40	5.4915	7.7641	611.52
117000.	247.13	5.2676	7.4255	612.43
118000.	247.86	5.0528	7.1017	613.33
119000.	248.16	4.8480	6.8058	613.70
120000.	248.41	4.6517	6.5237	614.00
121000.	248.65	4.4633	6.2534	614.30
122000.	249.25	4.2833	5.9869	615.04

TABLE VI. - GEMINI DENSITY SOUNDING, DEC. 16, 1965, 1922 G. m. t., EGLIN AFB GEOPHYSICAL RESULTS

Altitude, km	Density, kg/m^3	Temperature, °K	Pressure, millibar	Winds, m/sec		
				South	West	Total
100.00	5.69 -7	211	[a]3.44 -4			
99.01	7.34 -7	192	4.05 -4			
97.99	8.85 -7	190	4.83 -4			
96.99	9.89 -7	201	5.72 -4			
96.05	1.12 -6	208	6.66 -4			
94.99	1.39 -6	199	7.93 -4			
93.98	1.72 -6	192	9.42 -4			
93.01	1.97 -6	197	1.11 -3			
92.01	2.16 -6	210	1.31 -3			
90.97	2.55 -6	211	1.54 -3			
90.02	3.00 -6	209	1.79 -3			
88.97	3.70 -6	201	2.13 -3			
88.00	4.33 -6	202	2.50 -3			
87.00	5.23 -6	197	2.95 -3			
86.01	6.27 -6	195	3.50 -3			
84.97	7.61 -6	192	4.19 -3			
83.98	9.18 -6	189	4.97 -3			
83.00	1.11 -5	186	5.92 -3			
81.96	1.36 -5	184	7.15 -3			
81.00	1.60 -5	185	8.51 -3			
80.01	1.88 -5	188	1.01 -2			
79.02	2.18 -5	192	1.21 -2			
78.02	2.52 -5	197	1.43 -2			
77.01	3.00 -5	197	1.70 -2			
75.99	3.56 -5	198	2.02 -2			
75.00	4.14 -5	200	2.38 -2			
74.00	4.71 -5	207	2.81 -2			
72.99	5.34 -5	214	3.29 -2			
71.99	6.14 -5	218	3.84 -2			
70.98	7.35 -5	213	4.50 -2			
70.00	9.71 -5	190	5.29 -2	-69.8	24.4	74.0
68.99	1.14 -4	192	6.31 -2	-45.1	35.0	57.1
68.00	1.31 -4	198	7.48 -2	-36.7	36.0	51.4
66.99	1.51 -4	204	8.85 -2	-37.8	36.0	52.2
65.99	1.72 -4	210	1.04 -1	-37.7	45.9	59.5
65.00	1.96 -4	216	1.22 -1	-35.9	37.8	52.2
64.01	2.19 -4	224	1.41 -1	-32.5	40.0	51.6
63.01	2.44 -4	233	1.64 -1	-37.0	50.0	62.2
62.00	2.71 -4	242	1.89 -1	-38.3	47.5	61.0
61.01	3.01 -4	250	2.16 -1	-43.9	49.6	66.2
60.00	3.31 -4	259	2.46 -1	-39.0	52.7	65.5

[a]3.44 - 4 is used for 3.44×10^{-4}.

TABLE V. - ARCASONDE DATA FROM GRAND TURK ISLAND, DEC. 18, 1965.

AT 1410 G.m.t. - Concluded

Test no. 7427

Altitude, ft	Temperature, °K	Pressure, mb	Density, gm/m³	Velocity of sound, knots
123000.	250.07	4.1111	5.7272	616.05
124000.	250.89	3.9458	5.4789	617.07
125000.	252.57	3.7885	5.2257	619.12
126000.	255.98	3.6403	4.9542	623.29
127000.	259.39	3.4978	4.6977	627.43
128000.	262.62	3.3611	4.4587	631.32
129000.	262.01	3.2319	4.2972	630.59
130000.	261.40	3.1076	4.1417	629.85
131000.	260.79	2.9881	3.9917	629.12
132000.	260.25	2.8727	3.8454	628.47
133000.	259.73	2.7615	3.7040	627.84
134000.	259.21	2.6546	3.5678	627.21
135000.	259.15	2.5519	3.4304	627.14
136000.	259.58	2.4531	3.2922	627.66
137000.	260.01	2.3581	3.1596	628.17
138000.	260.21	2.2668	3.0349	628.42
139000.	259.54	2.1790	2.9248	627.61
140000.	258.87	2.0945	2.8187	626.80
141000.	258.20	2.0133	2.7165	625.98
142000.	257.53	1.9347	2.6172	625.17
143000.	256.85	1.8591	2.5215	624.36
144000.	256.18	1.7865	2.4294	623.54
145000.	257.67	1.7172	2.3217	625.35
146000.	260.35	1.6510	2.2092	628.59
147000.	263.04	1.5873	2.1023	631.82

TABLE VI. - GEMINI DENSITY SOUNDING, DEC. 16, 1965, 1922 G. m. t.,

EGLIN AFB GEOPHYSICAL RESULTS - Concluded

Altitude, km	Density, kg/m³	Temperature, °K	Pressure, millibar	Winds, m/sec		
				South	West	Total
59.01	3.66 -4	266	[a]2.80 -1	-22.8	50.5	55.4
58.01	4.05 -4	272	3.17 -1	-13.5	44.6	46.6
57.01	4.43 -4	281	3.58 -1	- 5.3	45.7	46.0
56.01	4.83 -4	290	4.02 -1	4.1	49.6	49.8
55.00	5.32 -4	296	4.52 -1	10.2	54.7	55.7
54.01	5.86 -4	300	5.05 -1	15.3	54.9	57.0
53.00	6.49 -4	303	5.65 -1	22.1	58.0	62.1
52.00	7.20 -4	306	5.31 -1	20.0	59.3	62.6
50.99	8.08 -4	305	7.06 -1	18.7	57.0	60.0
50.00	9.10 -4	302	7.88 -1	17.8	59.6	62.2
48.99	1.03 -3	299	8.82 -1	16.4	61.1	63.3
48.01	1.16 -3	296	9.87 -1	19.0	65.5	68.2
47.00	1.31 -3	294	1.11 0	19.2	69.5	72.1
46.00	1.48 -3	292	1.24 0	22.9	71.5	75.1
45.00	1.68 -3	289	1.40 0	21.5	69.5	72.7
44.00	1.92 -3	285	1.57 0	15.8	64.7	66.6
43.00	2.21 -3	279	1.77 0	10.9	69.0	69.8
42.00	2.54 -3	274	2.00 0	6.3	79.8	80.0
41.00	2.92 -3	270	2.26 0	2.7	87.0	87.1
40.00	3.35 -3	267	2.57 0	2.5	81.2	81.3
39.00	3.89 -3	261	2.92 0	3.3	73.1	73.2
38.00	4.56 -3	255	3.33 0	6.3	64.3	64.6
37.00	5.35 -3	248	3.81 0	13.1	54.2	55.8
36.00	6.25 -3	244	4.37 0	13.4	46.9	48.8
35.00	7.23 -3	242	5.02 0	7.0	43.2	43.8
34.00	8.38 -3	240	5.78 0	4.1	37.0	37.2
33.00	9.91 -3	235	6.67 0	3.0	29.4	29.6

[a]2.80 -1 is used for 2.80×10^{-1}.

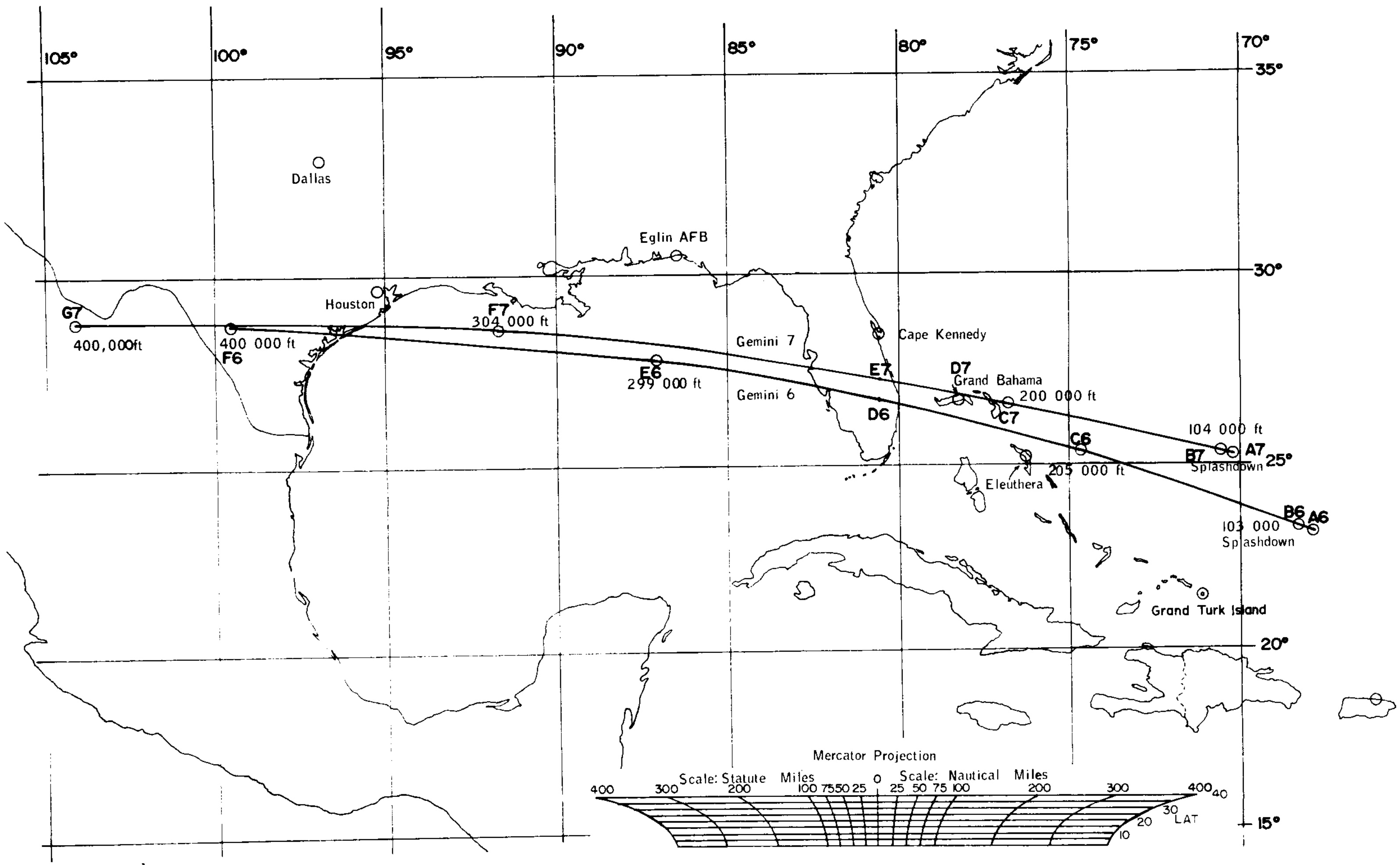


Figure 1.- Reentry ground track of Gemini 6 and Gemini 7 (A6, G7, etc., refer to figures 16 and 17).

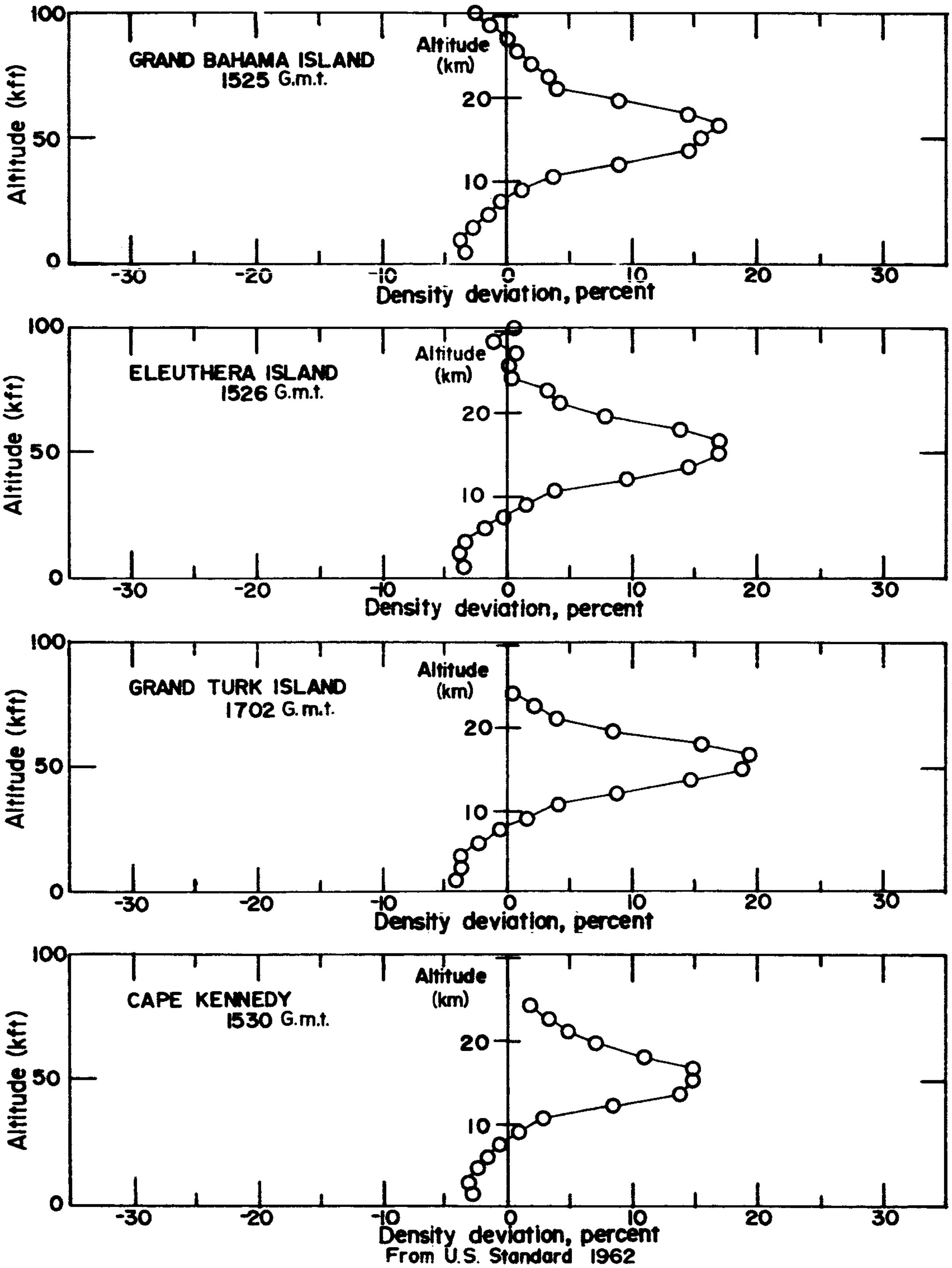


Figure 2.- Rawinsonde data for Gemini 6 reentry.

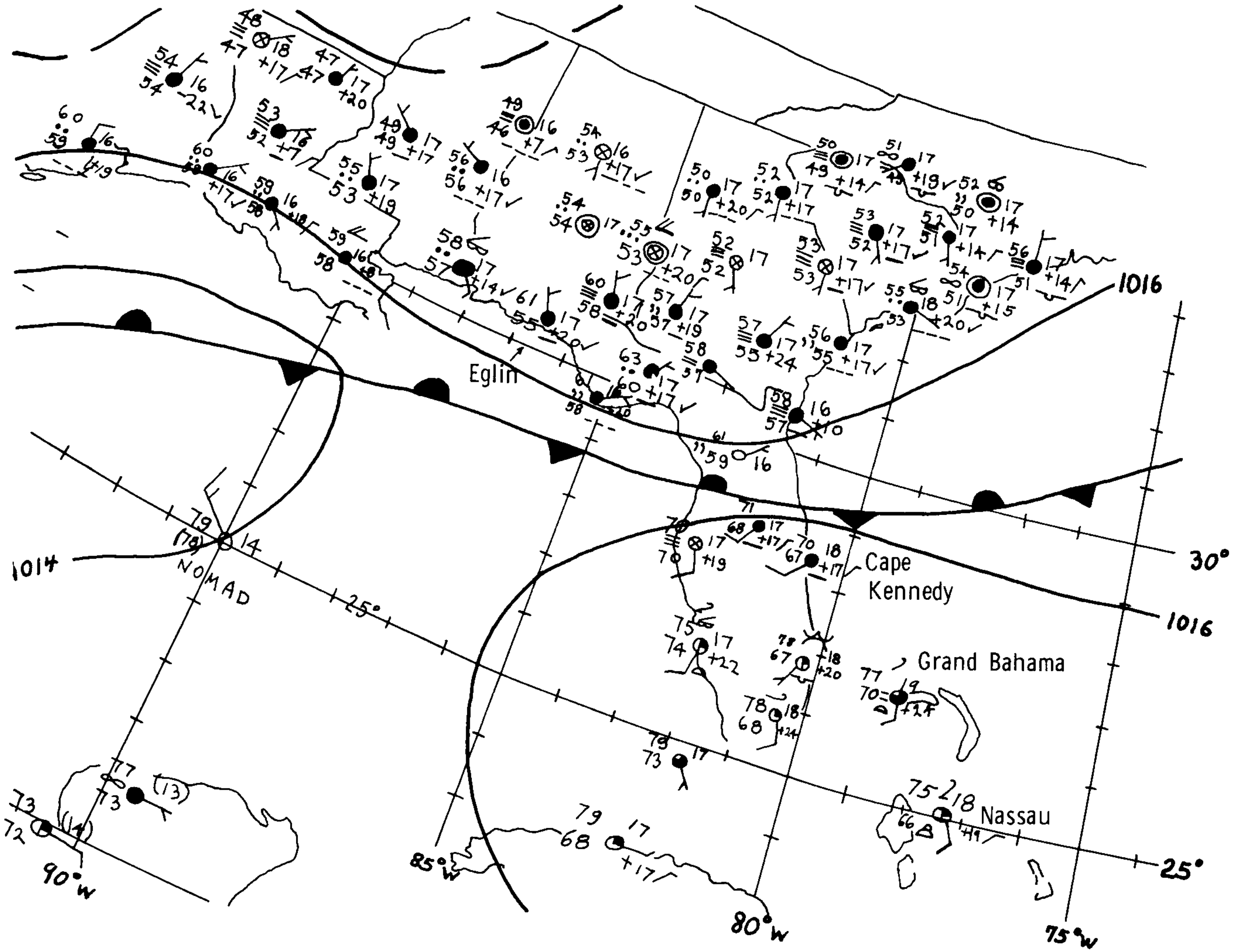


Figure 3.- Surface-weather analysis, December 16, 1965, 1500 G.m.t., Gemini 6.

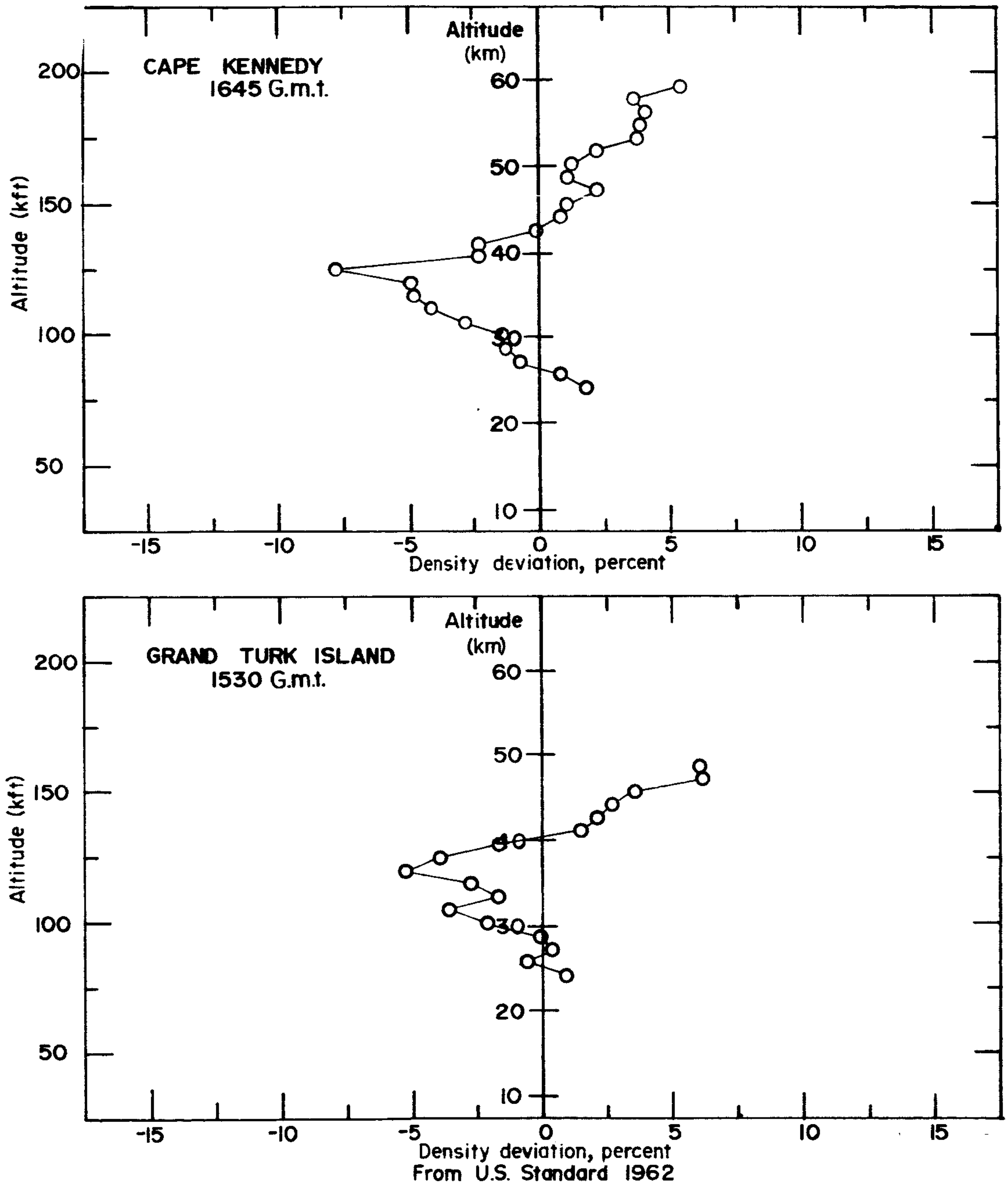


Figure 4.- Arcasonde data for Gemini 6 reentry.

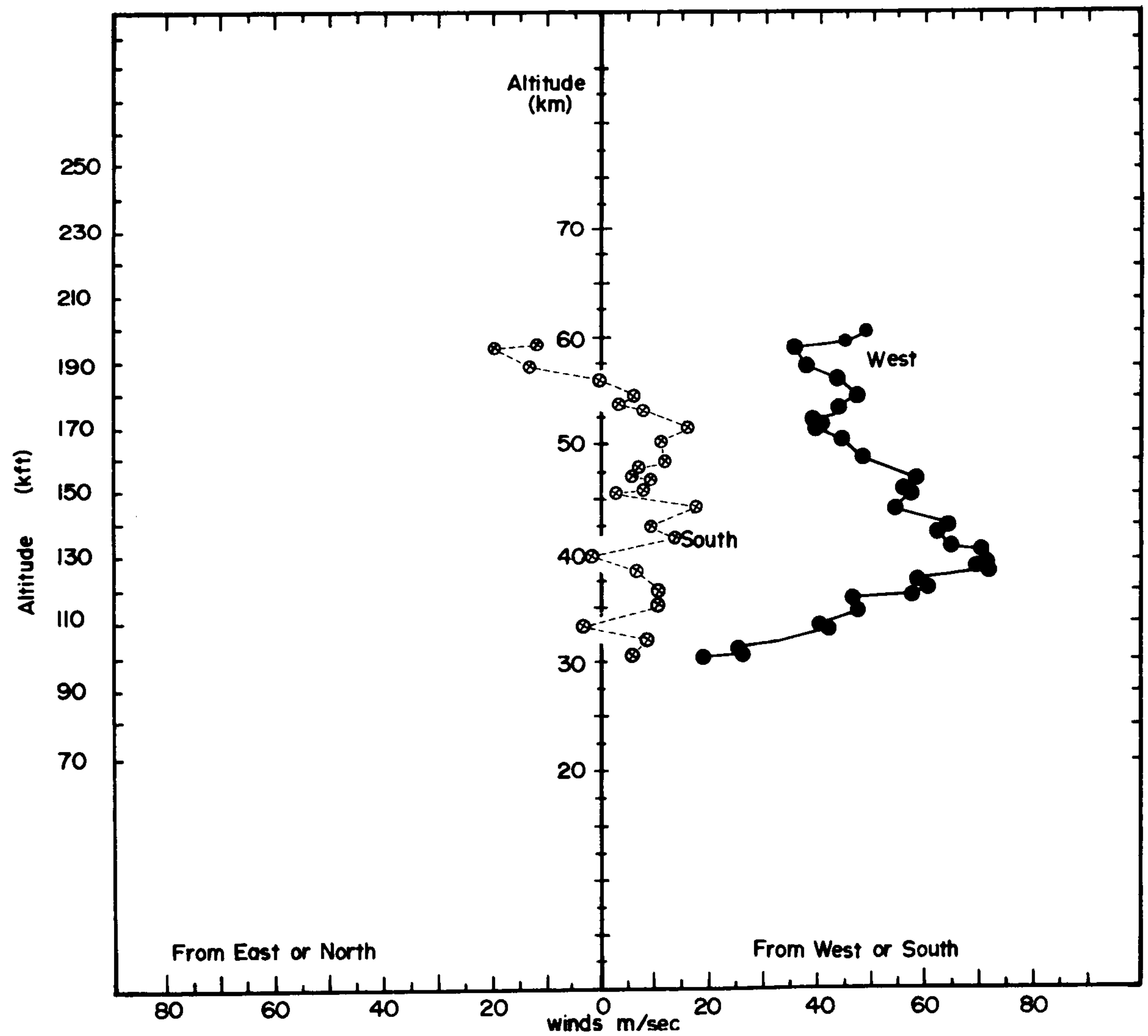


Figure 5.- Arcasonde winds for Cape Kennedy, December 16, 1965, 1645 G.m.t.

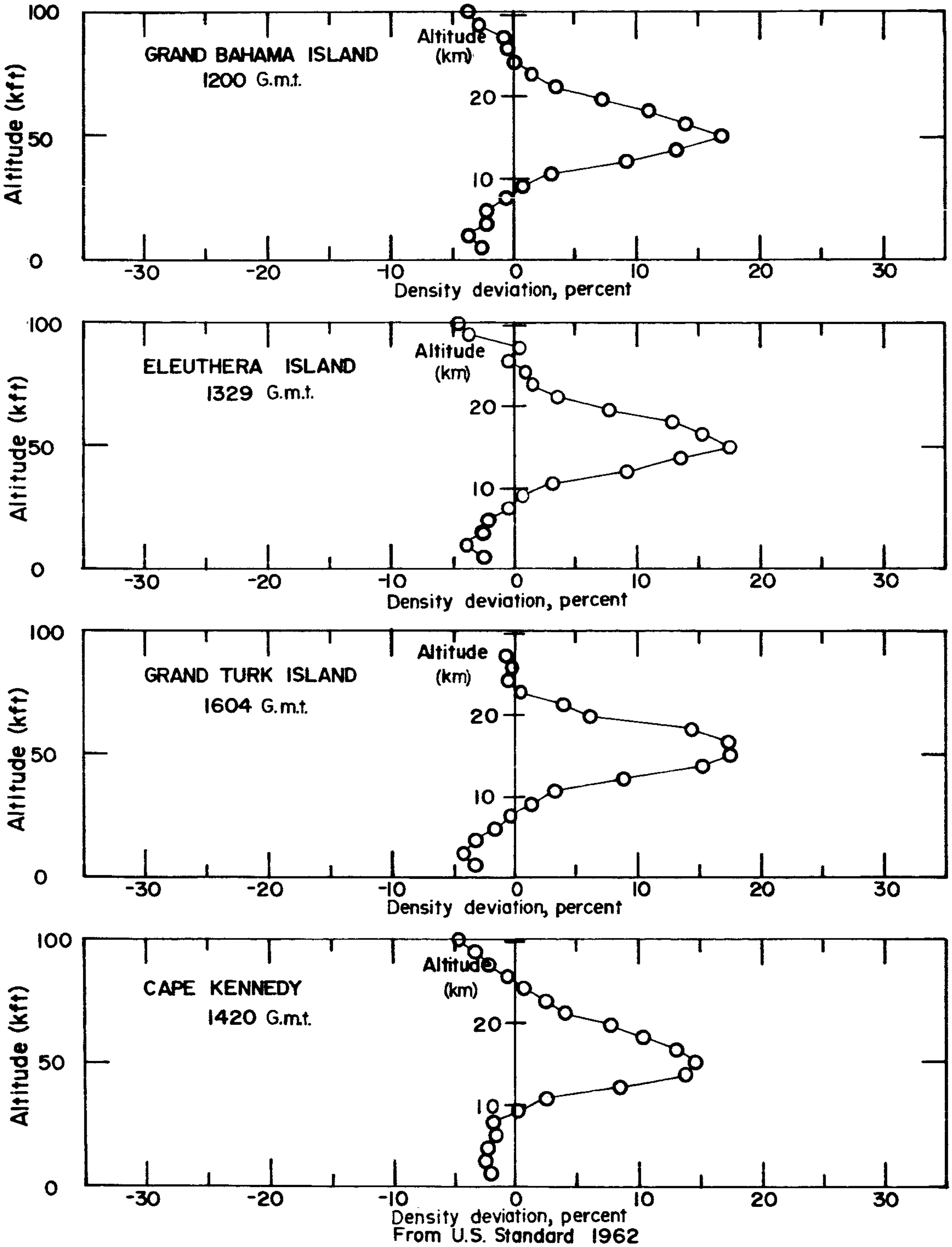


Figure 7.- Rawinsonde data for Gemini 7 reentry.

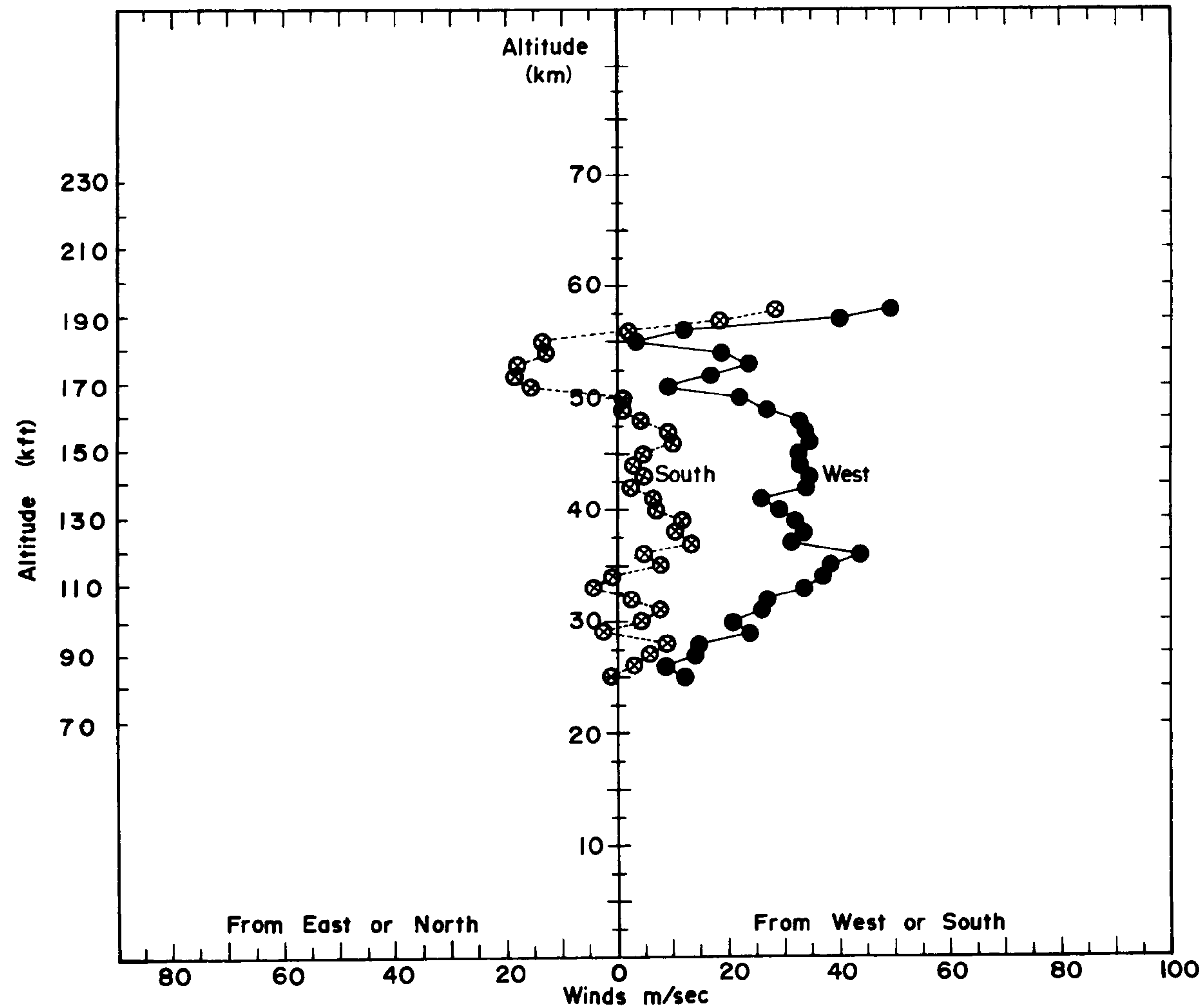


Figure 6.- Arcasonde winds for Grand Turk Island, December 16, 1965, 1530 G.m.t.

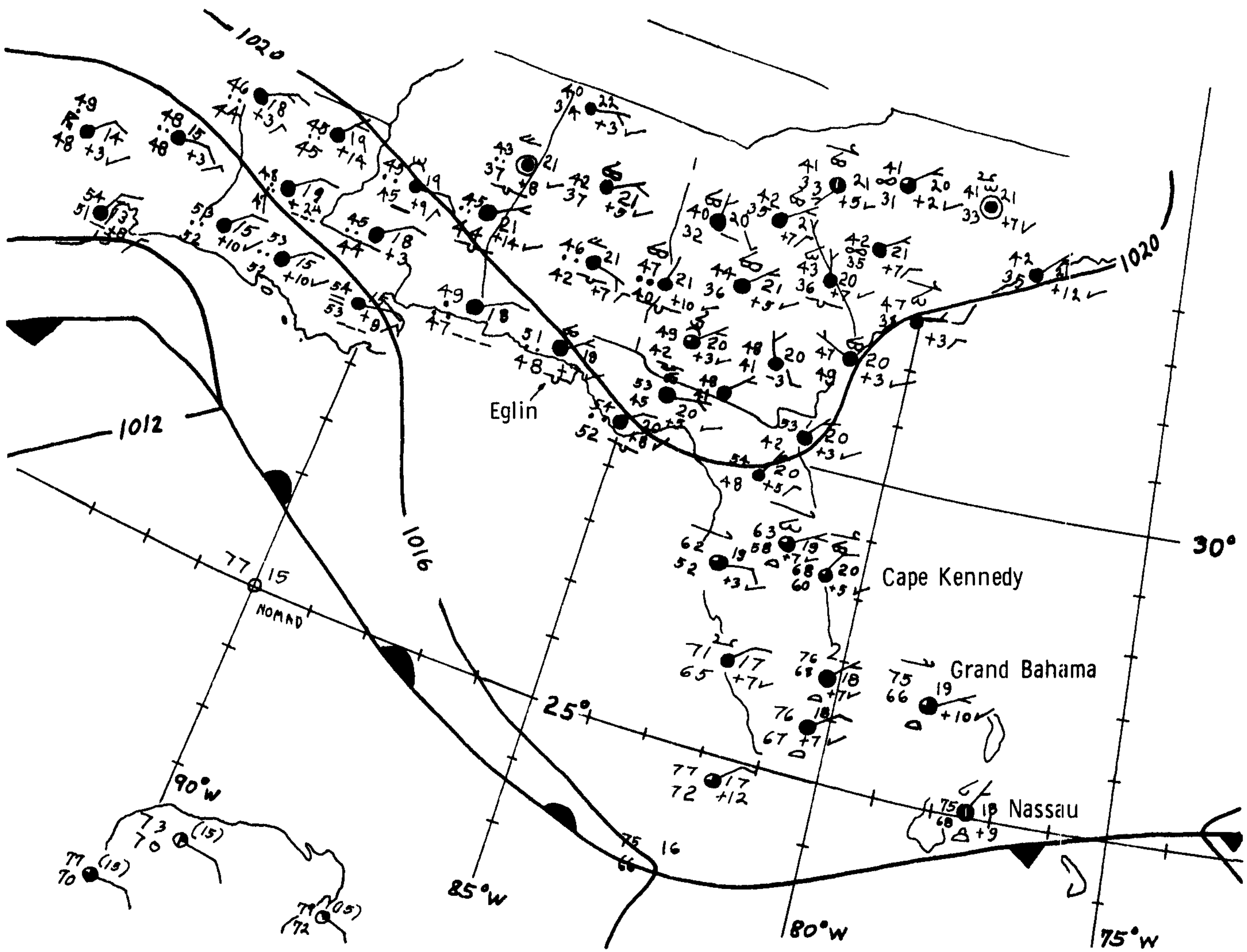


Figure 8.- Surface-weather analysis, December 18, 1965, 1500 G.m.t., Gemini 7.

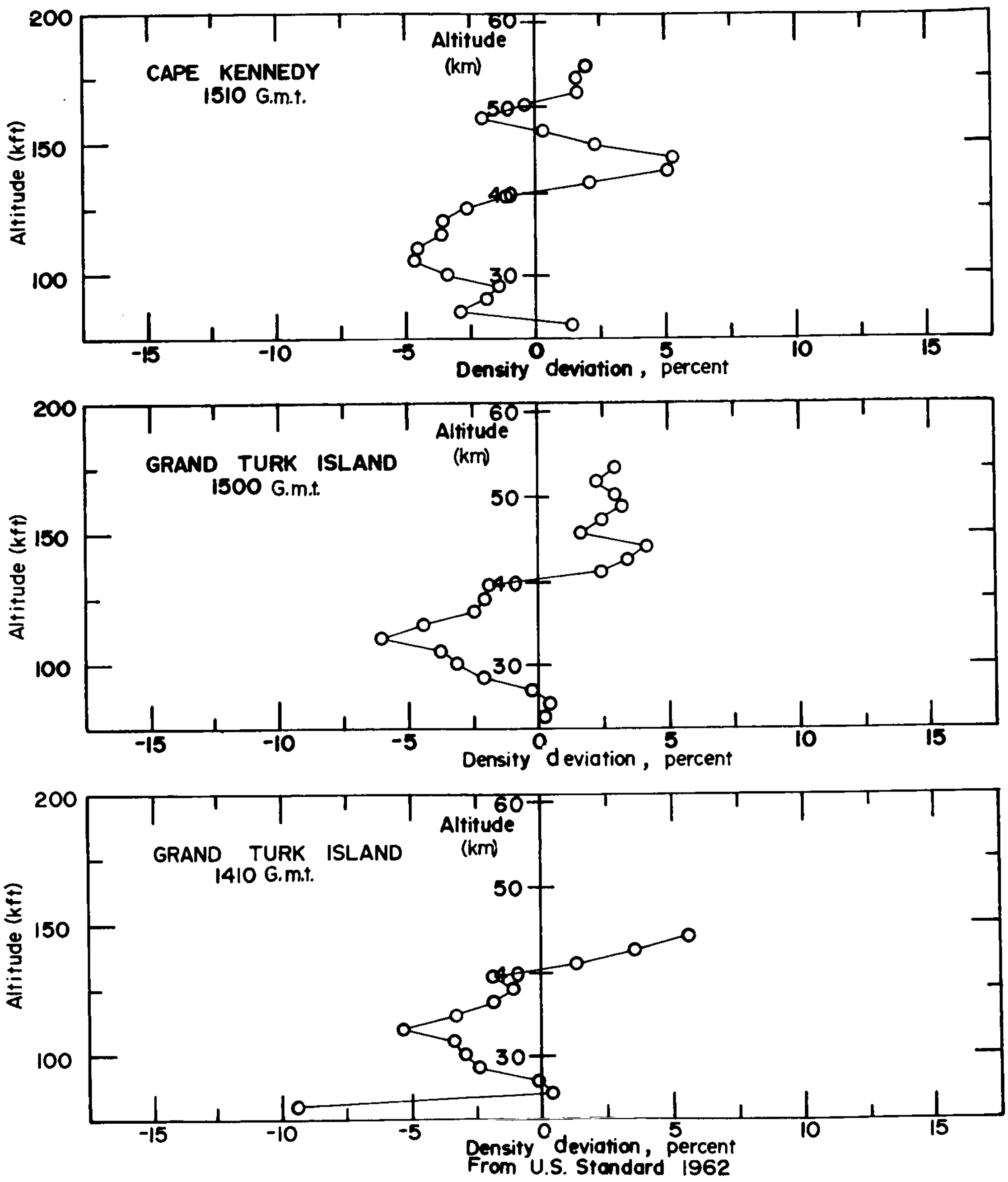


Figure 9.- Arcasonde data for Gemini 7 Reentry.

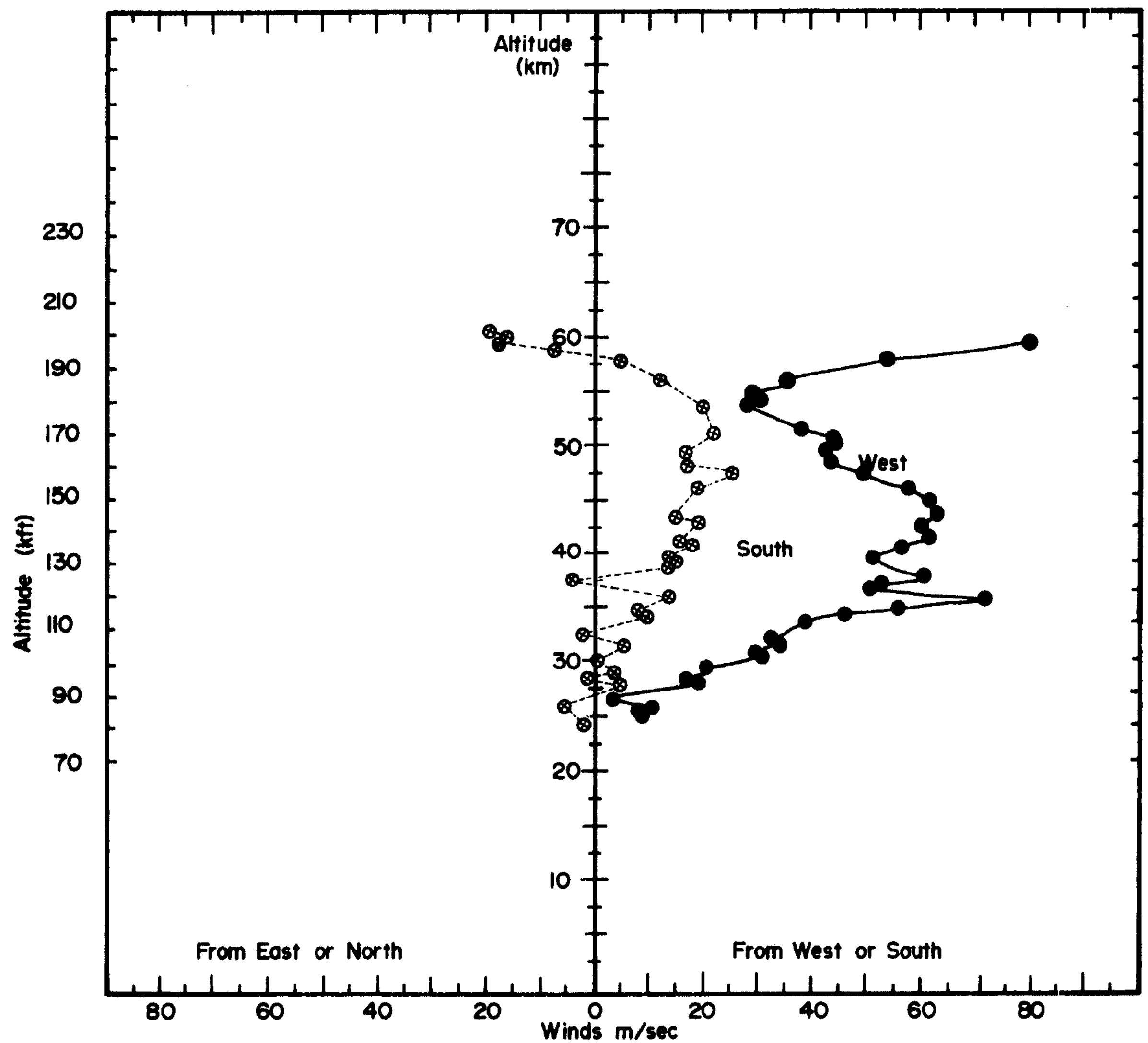


Figure 10.- Arcasonde winds for Cape Kennedy, December 18, 1965, 1510 G.m.t.

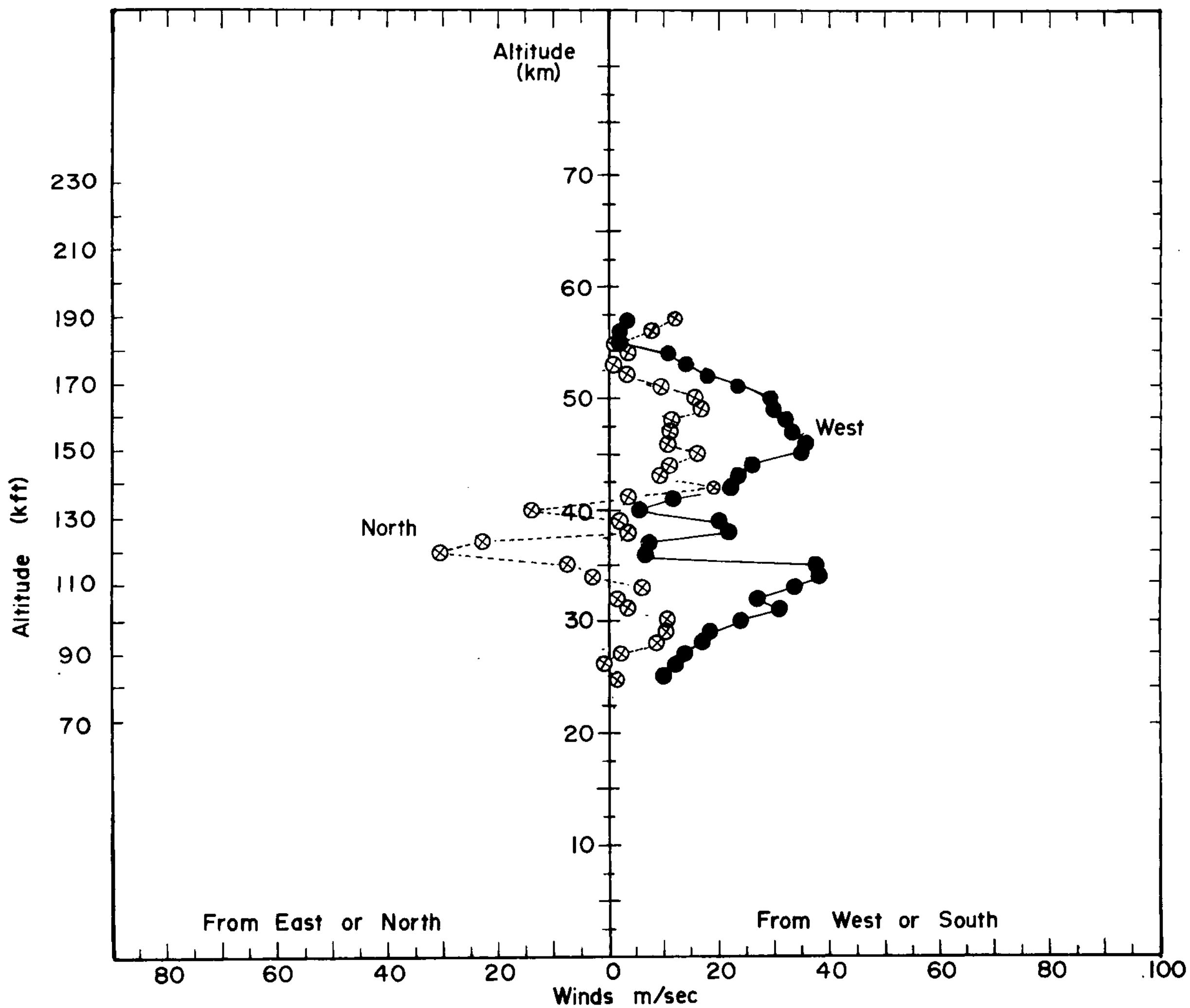


Figure 11.- Arcasonde winds for Grand Turk Island, December 18, 1965, 1500 G.m.t.

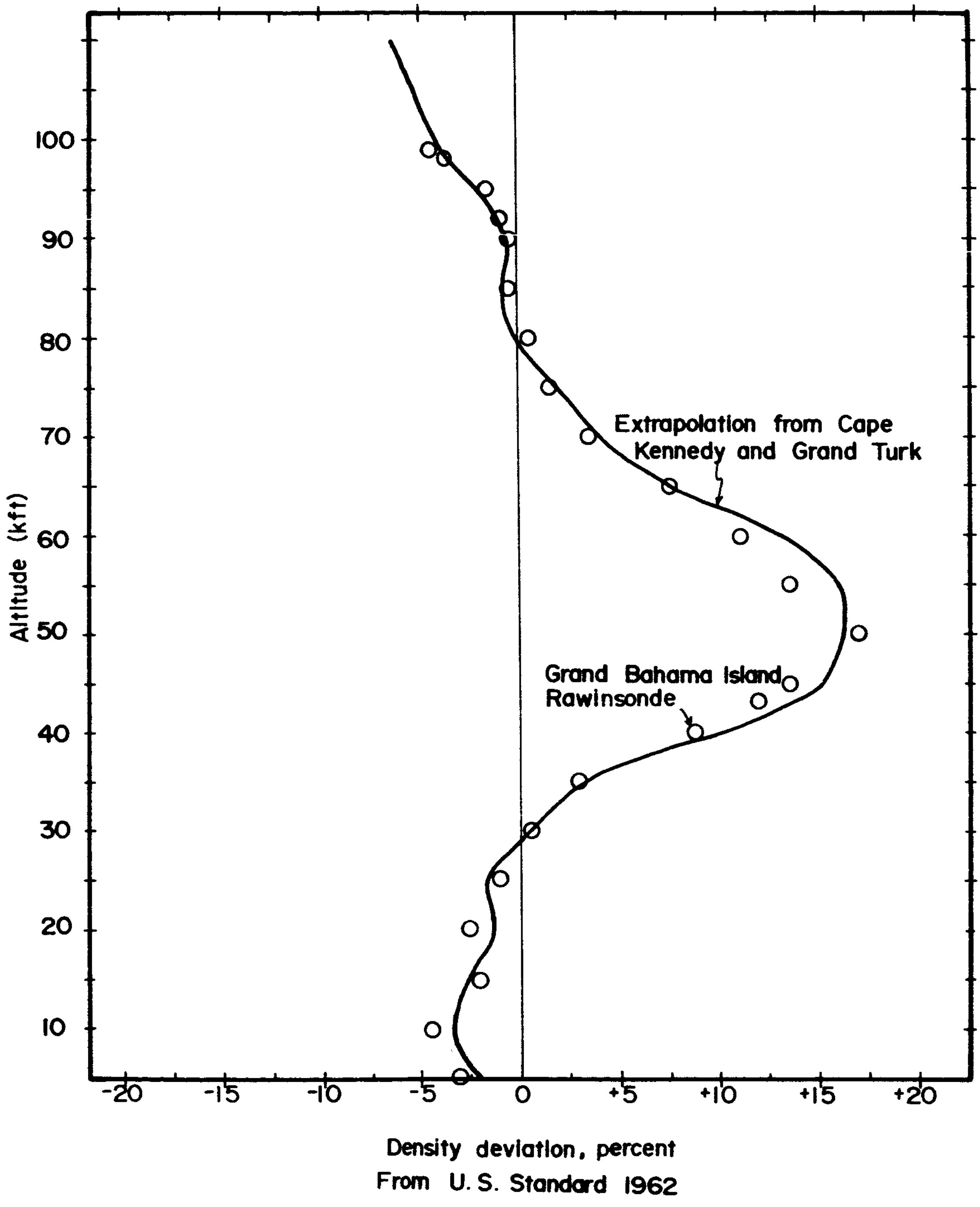


Figure 12.- Comparison of measured and extrapolated data.

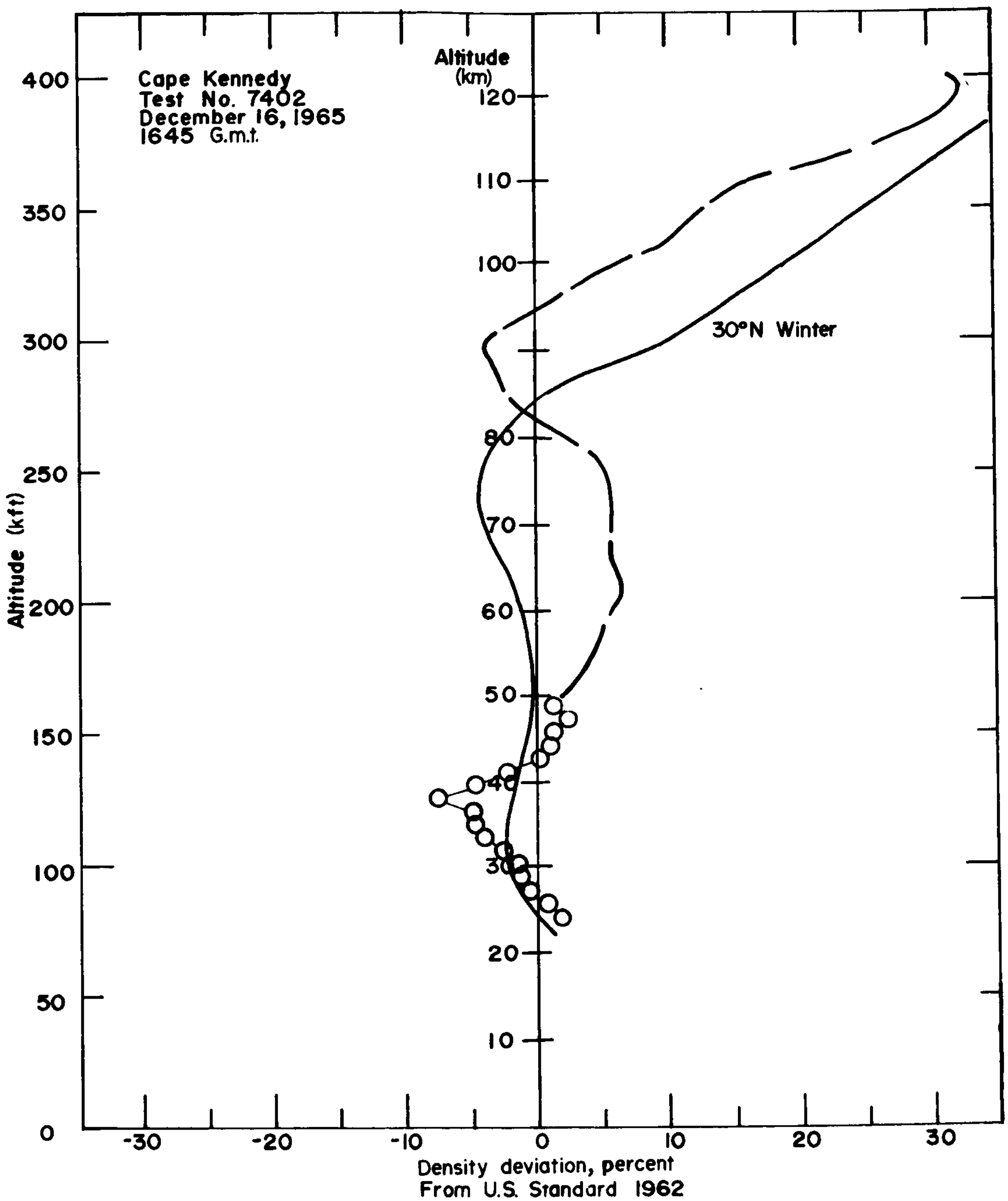


Figure 13.- Extrapolated Arcasonde data at Cape Kennedy for Gemini 6.

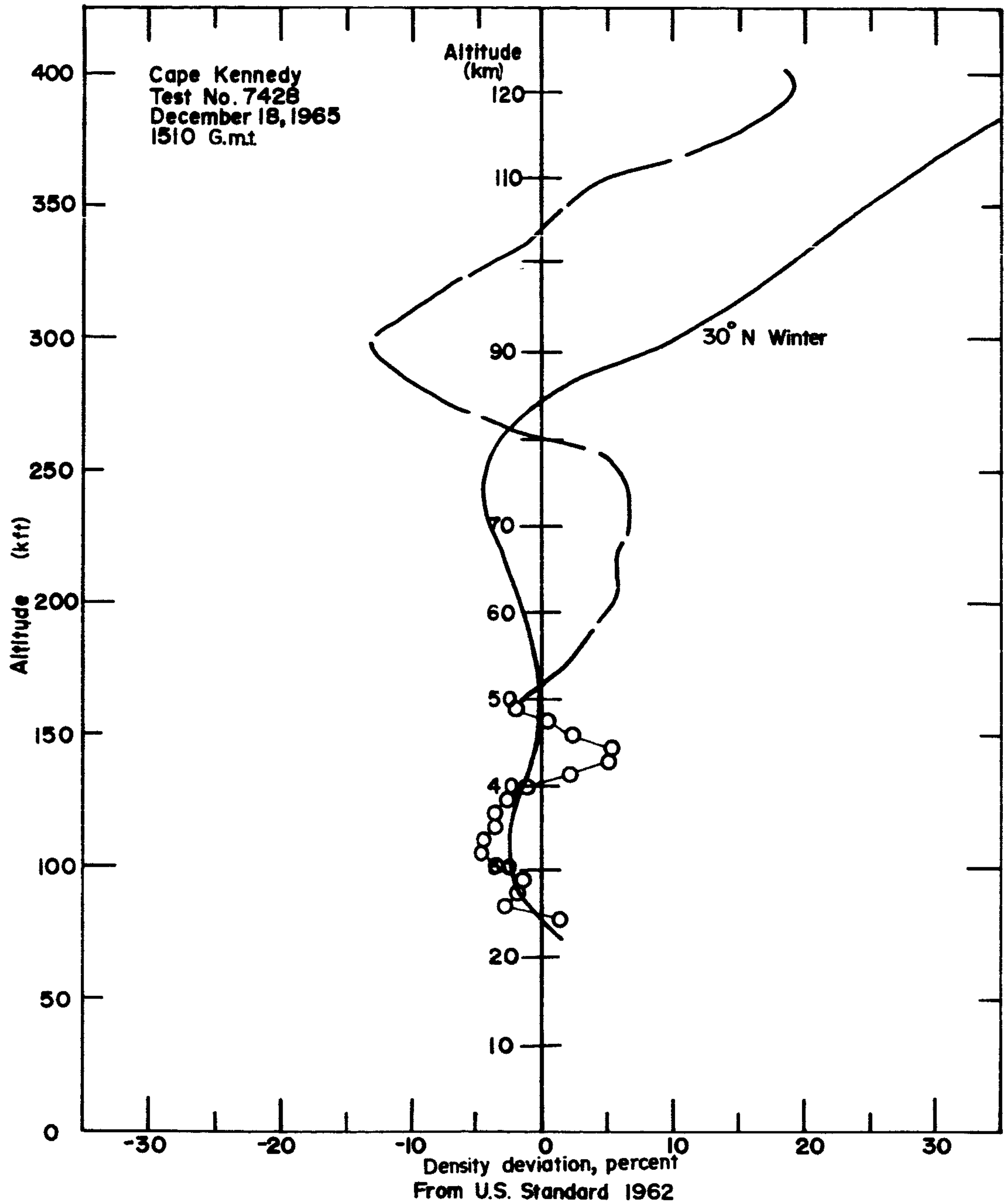


Figure 14.- Extrapolated Arcasonde data at Cape Kennedy for Gemini 7.

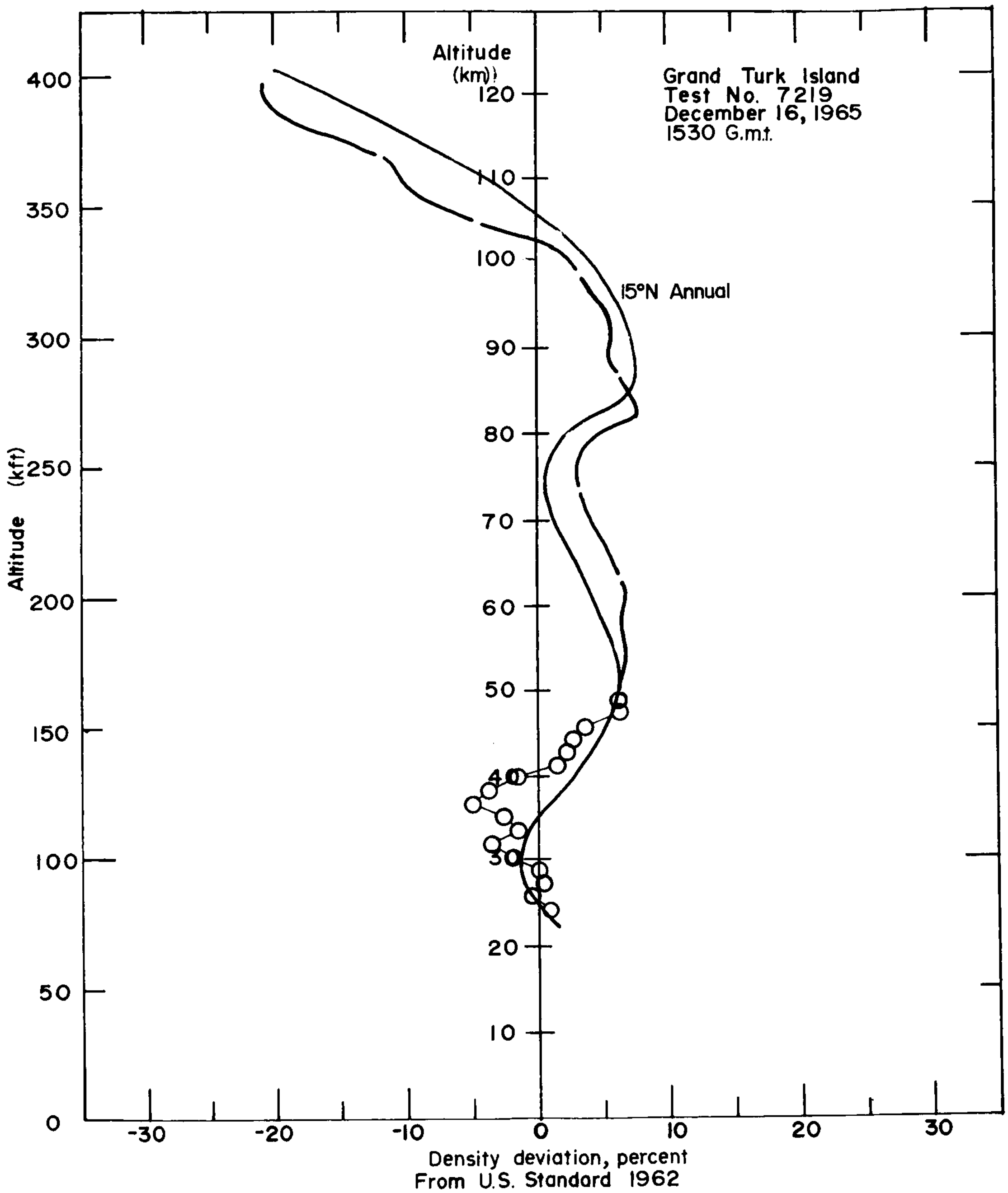


Figure 15.- Extrapolated Arcasonde data at Grand Turk Island for Gemini 6.

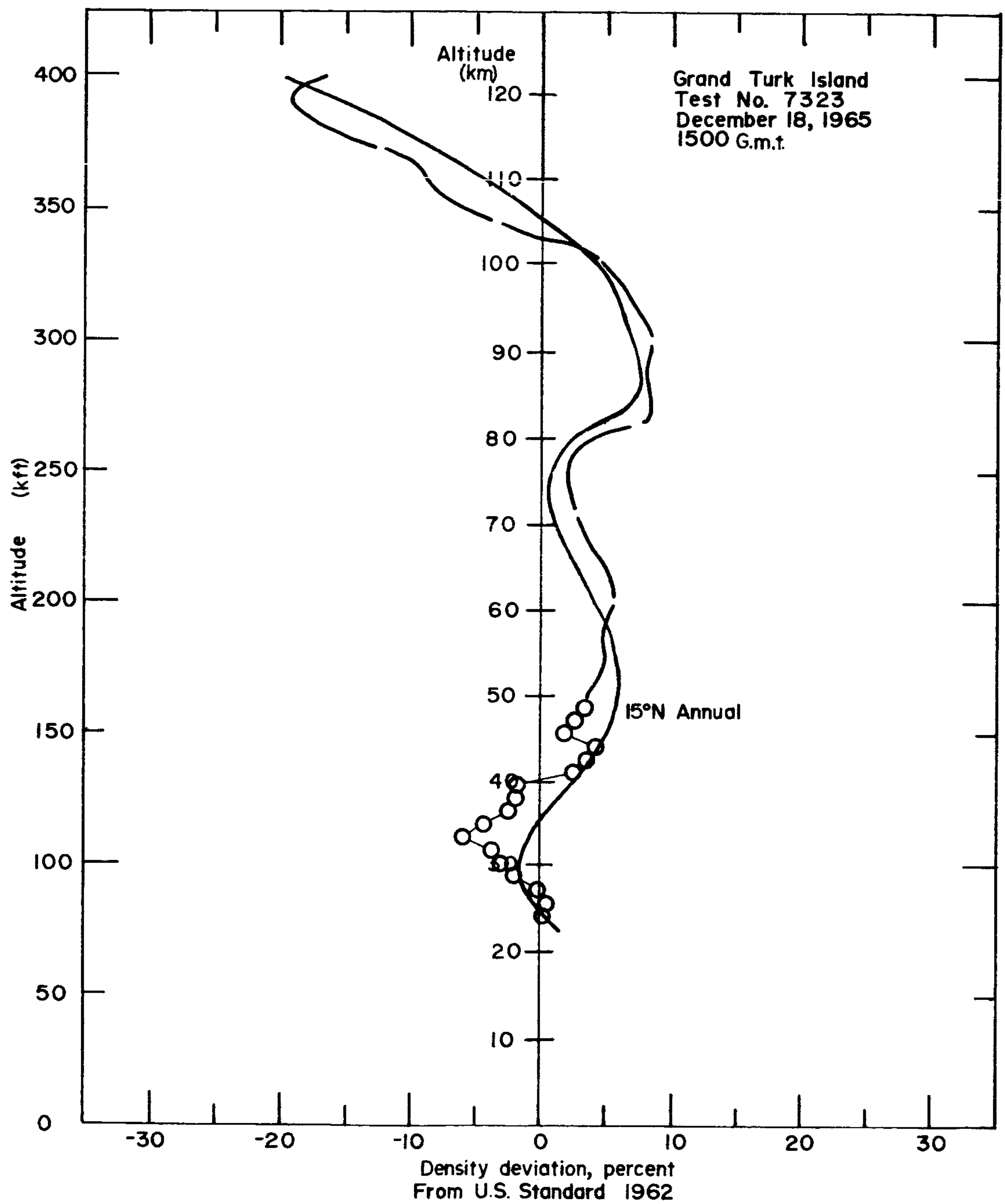


Figure 16.- Extrapolated Arcasonde data at Grand Turk Island for Gemini 7.

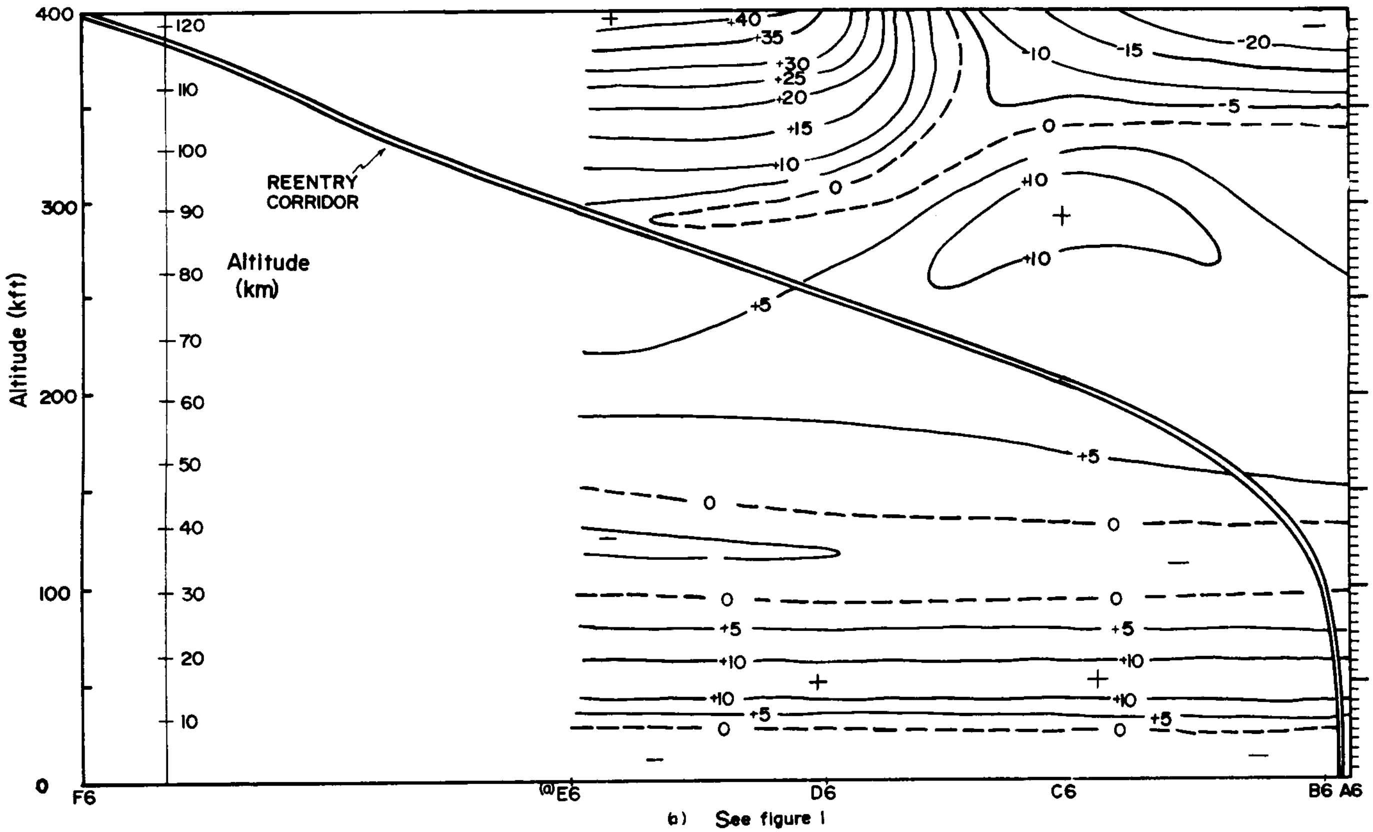
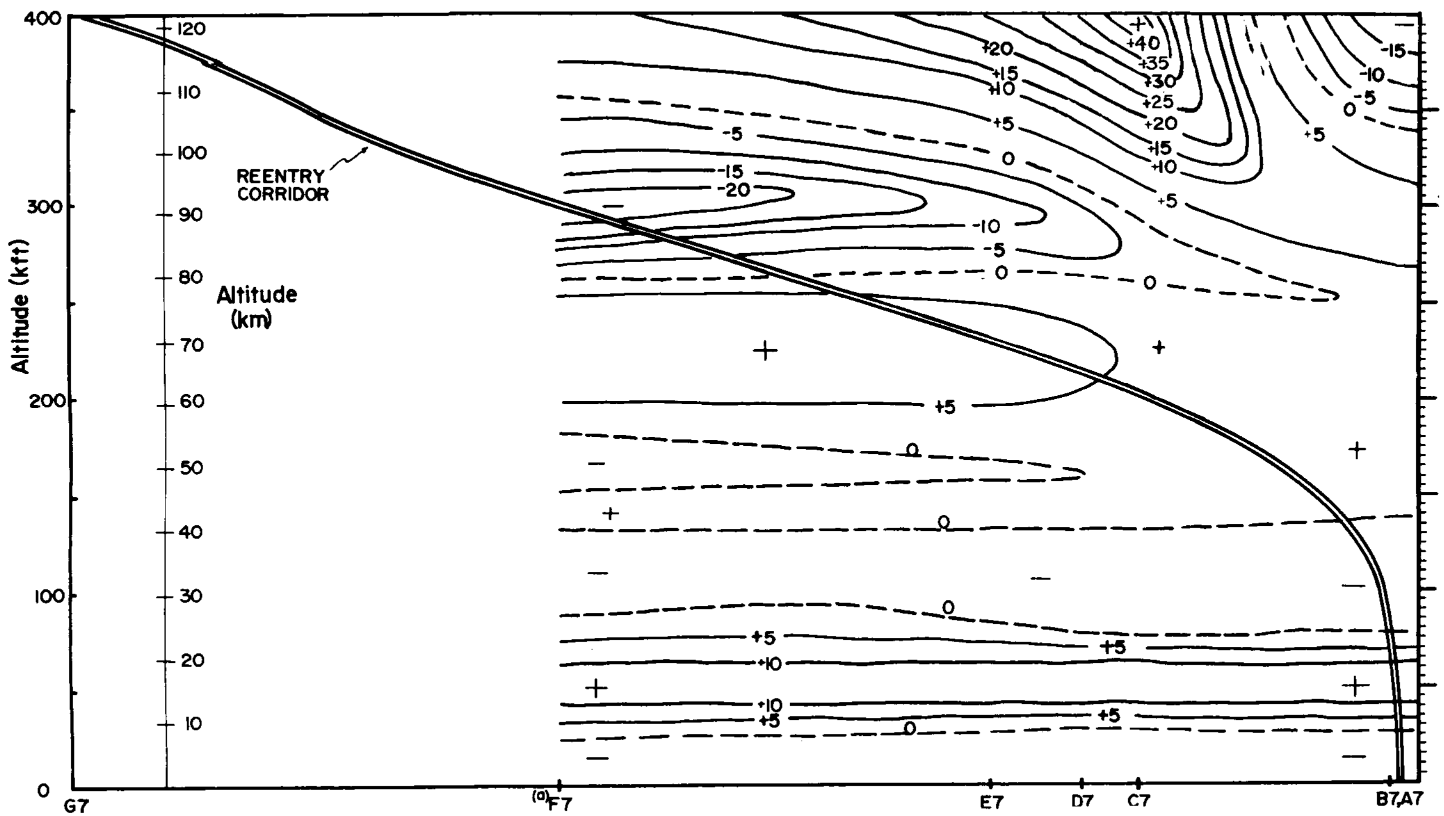


Figure 17.- Density deviation (percent) from U.S. Standard, 1962, for Gemini 6 reentry.



(a) See figure 1

Figure 18.- Density deviation (percent) from U.S. Standard, 1962, for Gemini 7 reentry.

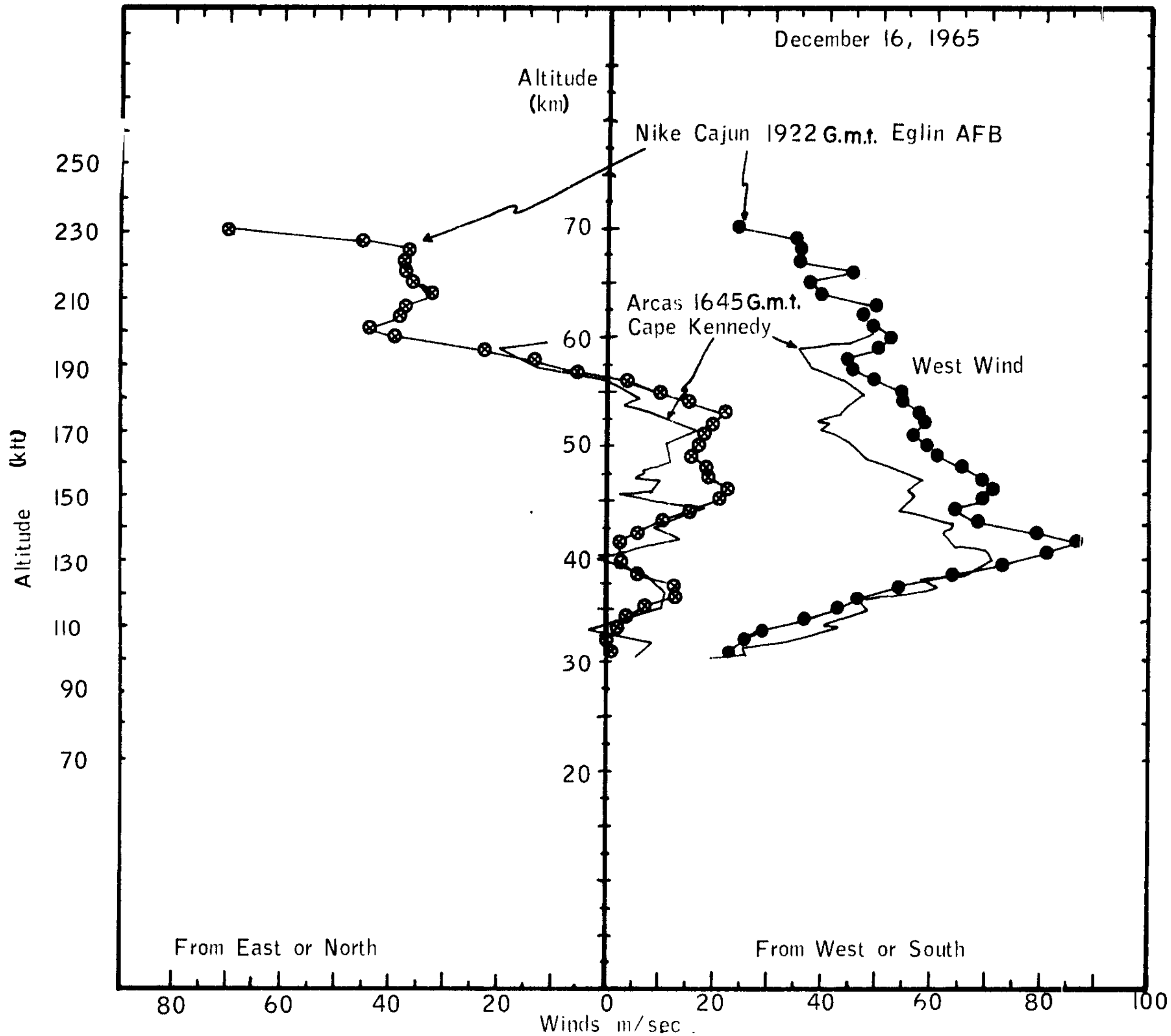


Figure 19.- Comparison of falling-sphere winds and Arcasonde winds for Gemini 6.

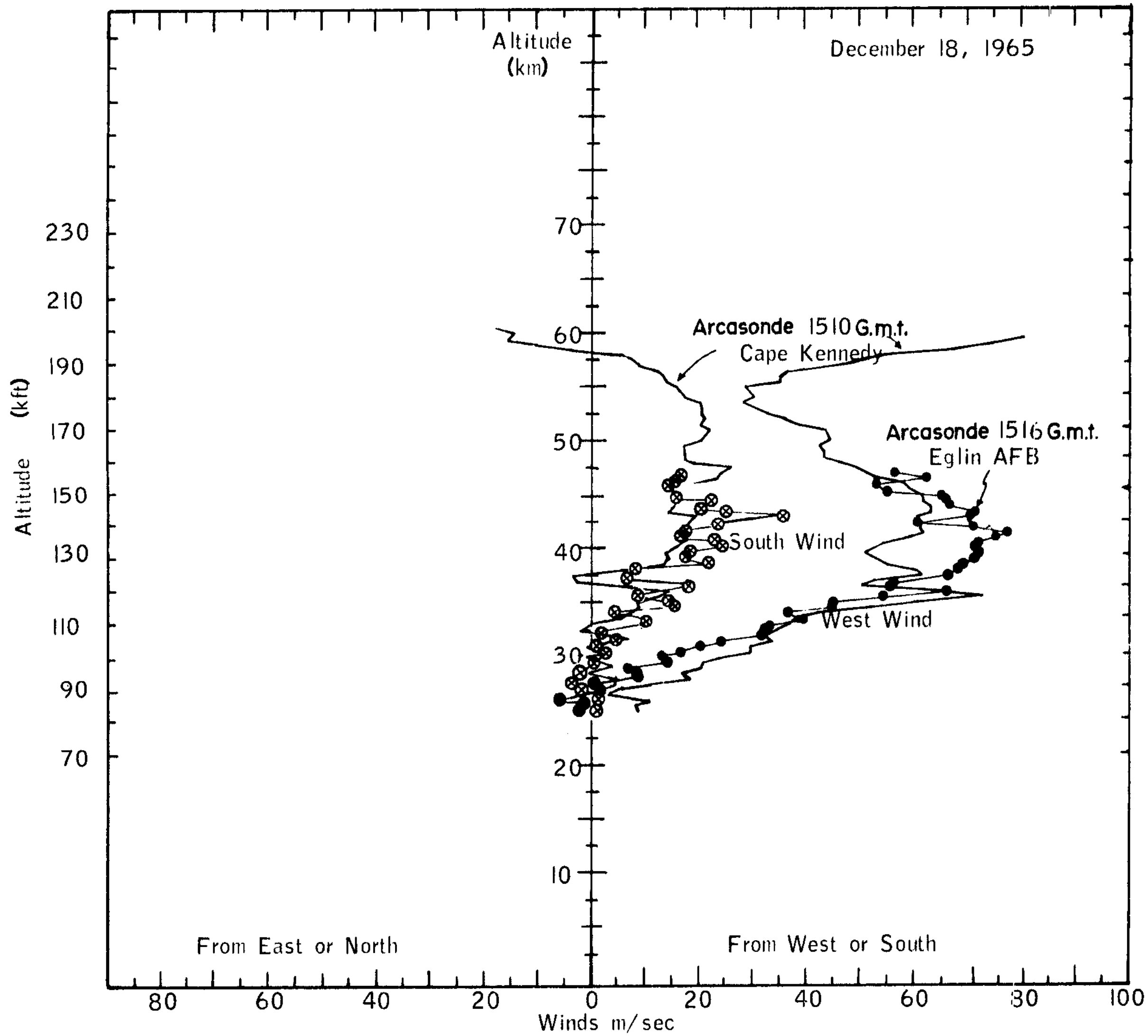


Figure 20.- Comparison of Arcasonde winds from Eglin AFB and Cape Kennedy for Gemini 7.

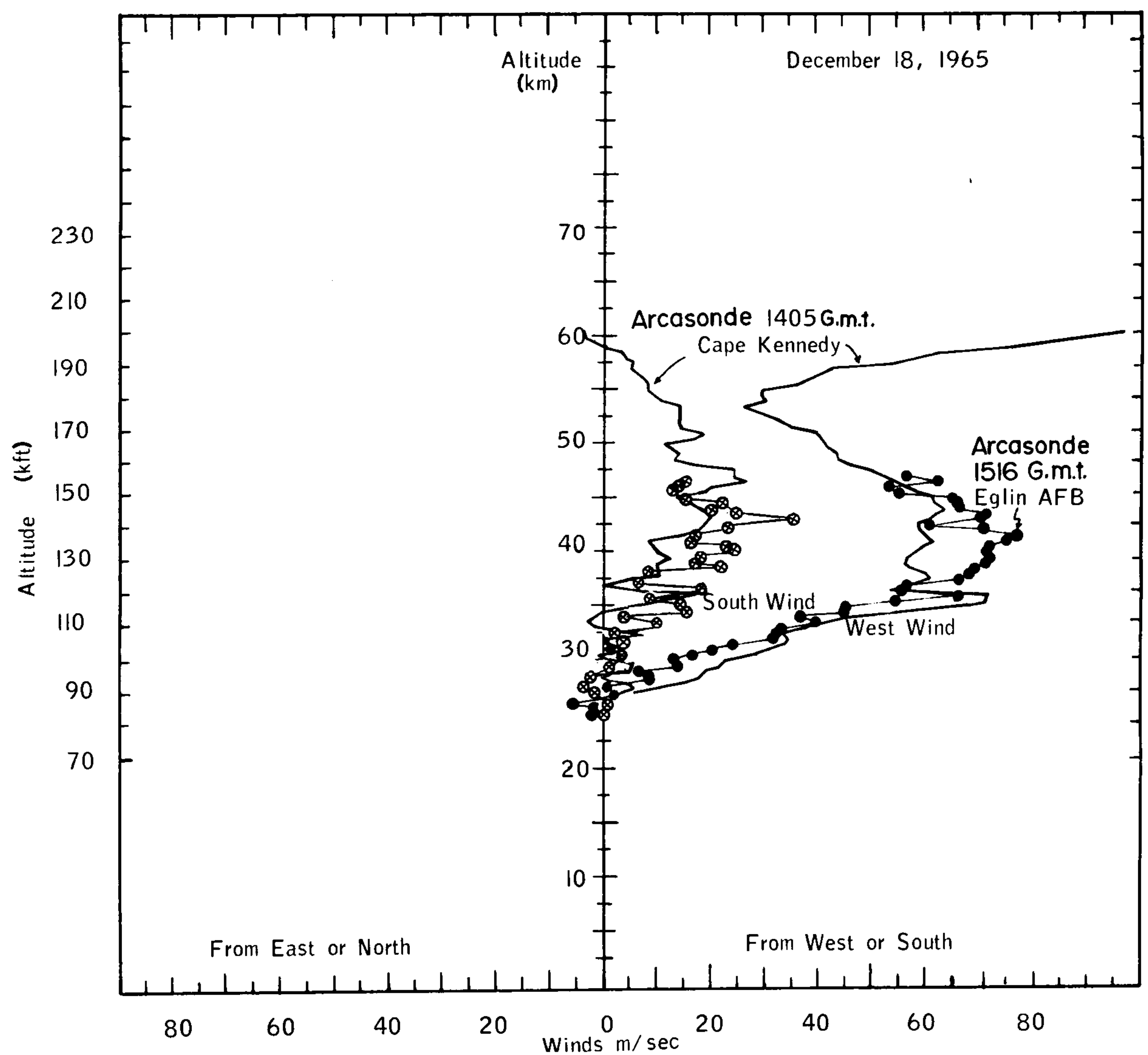


Figure 21.- Comparison of Arcasonde winds from Eglin AFB and Cape Kennedy for Gemini 7.

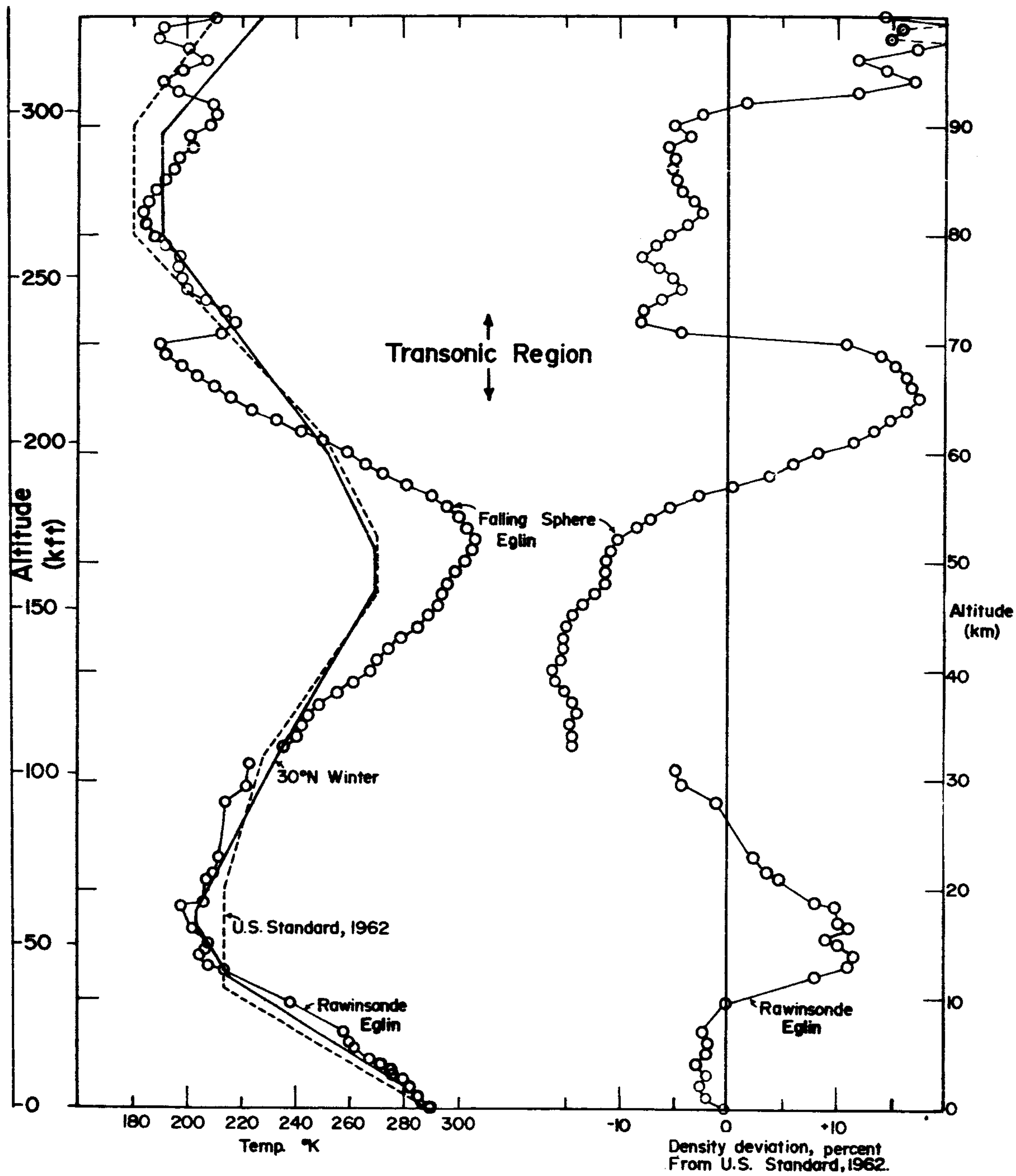


Figure 22.- Nike-Cajun falling-sphere data.

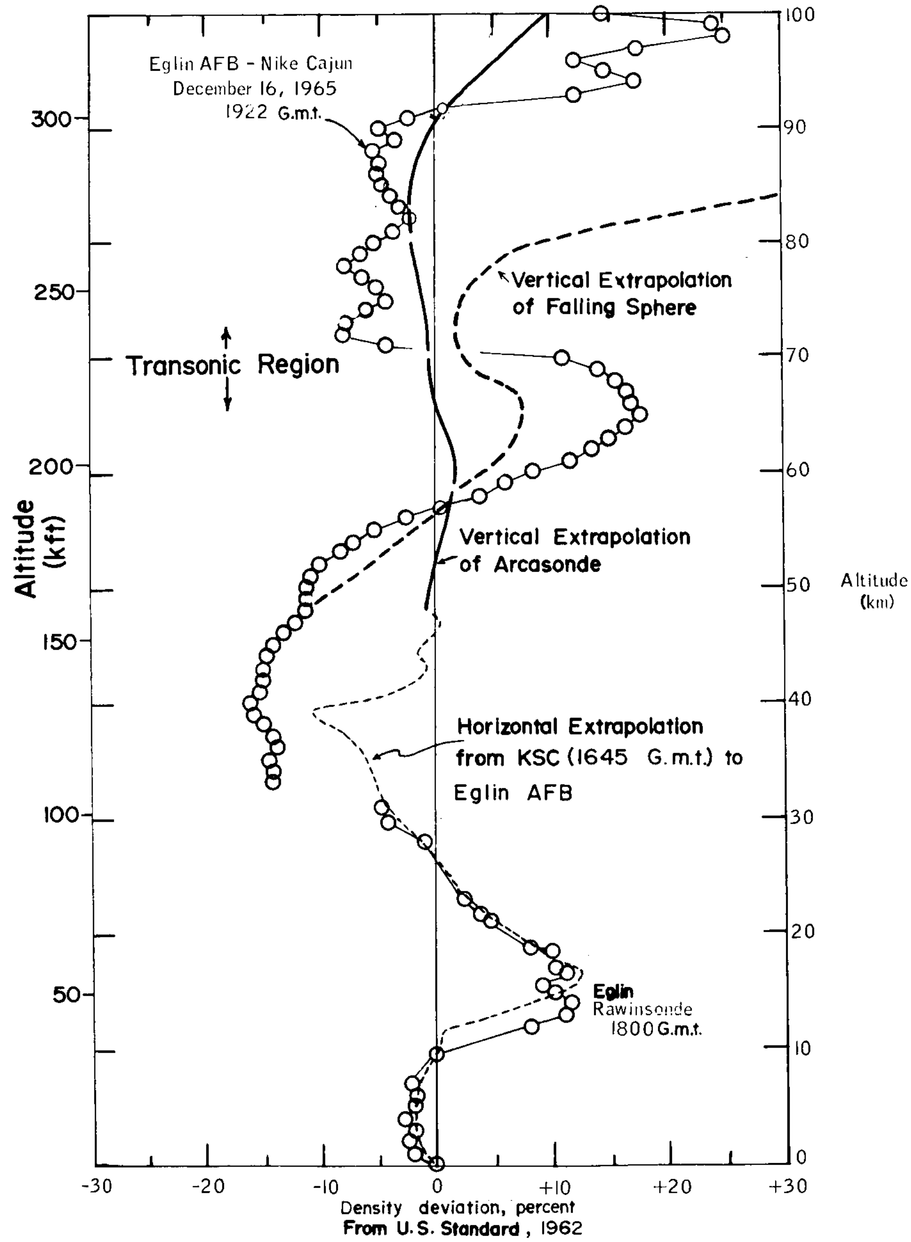


Figure 23.- Comparison of falling-sphere data to extrapolation from nearest Arcasonde.